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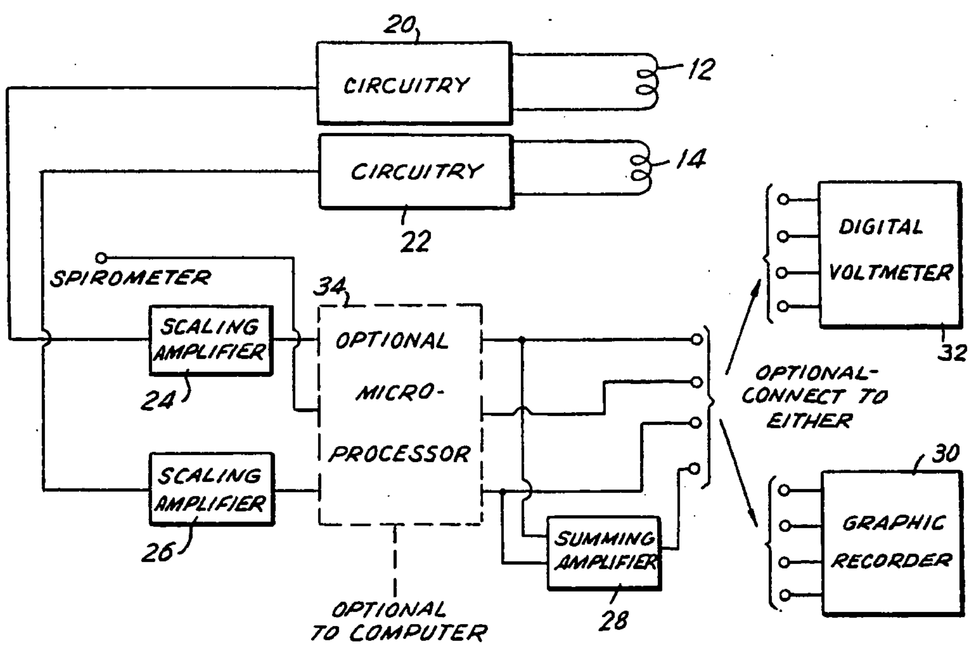

(57) Abstract

Method for non-invasively measuring respiration volume whereby weighting factors are non-invasively determined by (a) totaling delta values over a baseline period of substantially steady state breathing for obtaining a rib cage signal, (b) totaling delta values over a baseline period of substantially steady state breathing for obtaining an abdominal signal, (c) dividing the average variability of the mean of the total of the delta values for one of either the rib cage or abdomen signals by the average variability of the mean of the total of the delta values for the other of either the rib cage or abdomen signals; and (d) multiplying the other signal by the quotient derived from step (c).

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SINGLE POSITION NON-INVASIVE CALIBRATION TECHNIQUE FOR RESPIRATION MONITORING APPARATUS

Technical Field

This invention pertains to methods and apparatus for measuring respiration volume and, more particularly, to such methods and apparatus which measure respiration volume by separately measuring and then summing the contributions from a plurality of torso portions, such as the rib cage and abdomen. Most particularly, this invention pertains to a calibration technique for weighting signals indicative of the contributions from the torso portions whereby the sum of the signals is proportional to respiration volume.

Background Art

United States Patent No. 4,308,872 of January 5, 1982, entitled Method And Apparatus For Monitoring Respiration, the contents of which are incorporated herein by reference in their entirety, discloses a method and apparatus for quantitatively measuring respiration volume. The method disclosed in that patent comprises looping first and second extensible conductors about the rib cage and abdomen, separately and simultaneously measuring the inductances of the conductors during respiration, weighting the measured inductances to reflect the different contributions of the rib cage and abdomen to respiration volume, and summing the weighted measured inductances to obtain actual respiration volume.

As noted, practice of the technique disclosed in the patent requires weighting or calibrating the inductances measured by the abdomen and rib cage conductors. To effect calibration it is necessary to determine the weighting factors K and L to satisfy the following equation:

$$V = K \cdot RC + L \cdot AB \qquad \text{[EQUATION A]}$$

where V is total respiration volume, RC is the rib cage

contribution to respiration volume as measured at the rib cage conductor and AB is the abdominal contribution as measured at the abdominal conductor. Patent No. 4,308,872 discloses a specific technique for determining the values for the weighting factors K and L.

In accordance with that disclosure, a spirometer is employed during the calibration procedure. With the patient in a first position, such as standing, a simultaneous set of readings are recorded from the outputs of the spirometer, the rib cage conductor, and the abdominal conductor. This is repeated with the patient in a second position such as supine. At this point, there are two sets of values for V, RC, and AB which satisfy Equation A. Thus, two equations having two unknowns, the constants K and L, may be written. From these, the weighting factors K and L may be determined by employing well known techniques for solving simultaneous equations. Thus:

$$K = \frac{AB_1 \cdot V_2 - AB_2 \cdot V_1}{RC_2 \quad AB_1 - RC_1 \quad AB_2} \qquad \text{[EQUATION B]}$$

$$L = \frac{RC_1 \cdot V_2 - V_1 \cdot RC_2}{AB_2 \quad RC_1 - AB_1 \quad RC_2} \qquad \text{[EQUATION C]}$$

The denominators of Equations B and C may, depending upon the recorded values, approach or equal zero. Clearly, when this happens, the values obtained for K and L will be inaccurate, thereby skewing any measurement based on such weighting factors. Thus, each time the denominators of Equations B and C approach or equal zero, a new set of readings must be taken, thereby increasing the time required for calibration.

In U.S. Patent No. 4,373,534 of February 15, 1983, entitled Method And Apparatus For Calibrating Respiration Monitoring System, the contents of which are also incorporated herein by reference in their entirety, an alternate method and apparatus for a graphing-based technique for determining the weighting factors K and L is disclosed. As in the simultaneous equation technique of

U.S. Patent No. 4,308,872, a spirometer or other device for independently measuring respiration volume is employed during the calibration procedure. With the subject in a first position, readings from the spirometer, the rib cage conductor and the abdominal conductor are simultaneously recorded for a plurality of breaths, preferably at least three in number. This is repeated with the subject in a second position. For each breath, the rib cage and abdominal readings are divided by the spirometer reading. That is, the values RC/V and AB/V are obtained for each breath, where V is the respiration volume as measured by the spirometer, RC is the rib cage reading from the uncalibrated rib cage conductor, and AB is the abdominal reading from the uncalibrated abdominal conductor. The points (RC/D, AB/V) for each breath are next plotted on a graph whose axes are RC/V and AB/V, and a line approximation is drawn through these points. The line may be drawn by visual approximation, although preferably it is determined by the least squares technique. The line is then extended through the x and y axes. The reciprocals of the x and y intercepts define the weighting factors K and L; i.e. the reciprocal of the intercept of the RC/V axis defines the weighting factor K for the rib cage and the reciprocal of the intercept of the AB/V axis defines the weighting factor L for the abdomen. Preferably, all of the foregoing calculations are carried out by a microprocessor or other data processor which performs the calculations and yields values for the weighting factors K and L.

A drawback of the methods and apparatus disclosed in U.S. Patents Nos. 4,308,872 and 4,373,534 is the requirement that sets of data points or values -- from the abdominal and rib cage conductors and from the spirometer or other respiration volume measurement device -- be obtained with the subject for two different distributions of ventilation -- i.e. in two separate positions. Where a subject's physiological condition prevents or dictates against movement from one position to another, however, calibration of the rib cage and abdominal conductor

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contributions cannot be readily carried out in accordance with the known methods.

Another drawback of these prior art methods and apparatus is that in certain applications, such as neo-natal monitoring, it is not practical to calibrate the apparatus using an independent respiration volume measuring device such as a spirometer. For example, since the above calibration techniques require airway connection to a spirometer or other similar device, significant time is required to carry out the procedure. This is often unacceptable to new-born nursery staff where time is at a premium.

Yet another problem with these calibration techniques and apparatus is that they rely on the assumption that all air movement in the respiratory system is between the rib cage and spirometer or the abdomen and the spirometer. In fact, there also exists movement of air between the rib cage and the abdomen during normal respiration. This RC-AB exchange of air is pendelluft that occurs continuously and with varying degree in respiration. The known methods do not incorporate an allowance for pendelluft.

Another known quantitative calibration technique is described in Single Position Tidal Breathing Calibration of the Respiratory Inductive Plethysmograph, Watson et al, Amer. Rev of Respiratory Diseases, Vol. 129, p. A256 (1984). According to that technique, with the subject in a single position or posture, readings from a spirometer (SP), the rib cage conductor (RC), and the abdominal conductor (AB) are simultaneously recorded for a predetermined period of preferably at least one full breath. The curves (SP, RC) and (SP, AB) are then plotted from the recorded data and each resulting curve is closed by a straight line connecting its beginning and end point. The resulting loop areas are then calculated as by integration. Then, using any selected data points simultaneously recorded from the spirometer (SP) and from the rib cage (RC) and abdominal (AB) conductors, weighting factors (for the rib cage scaling amplifier and/or for the abdomen scaling amplifier) may be determined. This calibration technique also suffers from the drawback that it is invasive in the sense that it requires a spirometer or other device measuring respiration volume at the mouth.

Brief Description Of The Drawings

In the drawings, wherein like reference numberals denote similar elements throughout the several views:

FIG. 1 is a diagrammatic representation of a portion of a system for non-invasively monitoring respiration volume;

FIG. 2 is a block diagram of a complete system for non-invasively monitoring respiration; and

FIG. 3 is a graphic representation illustrating the delta values for the rib cage and abdominal signals.

Best Mode For Carrying Out The Invention

Referring now to the drawings, apparatus for measuring respiration volume of the type disclosed in U.S. Patent No. 4,306,872 is shown in FIGS. 1 and 2. Two extensible conductive loops 12, 14 are secured in any suitable fashion to elastic tubes 16, 18, respectively, such that the conductors 12 and 14 extend respectvely about the rib cage and abdomen of the subject 10. As the subject 10 breathes, the elastic tubes 16, 18 and conductive loops 12, 14 expand and contract, resulting in changes in the inductances of the loops. After the inductance of each loop is converted to a proportional signal, the signals are calibrated and then summed to provide a signal indicative of tidal volume. Calibration of the signals from the rib cage and abdomen conductors 12 and 14, respectively, is necessary because the relative contributions of the rib cage and abdomen to tidal volume vary from subject to subject and even in a single subject with different postures, e.g. standing, supine, etc.

Suitable apparatus for converting the inductances of the conductors 12 and 14 to proportional electrical signals, calibrating those signals to reflect the proper relative contributions, and then summing those signals to provide a signal indicative of tidal volume are known to those of ordinary skill in the art. One such apparatus is disclosed in U.S. patent no. 4,306,872. Another suitable apparatus is marketed by Nims, Inc., Miami Beach, Florida under the model designation Respigraph ™. Such apparatus are generically illustrated in block diagram form in FIG. 2, where the blocks 20, 22 represent, respectively, appropriate circuitry for converting the inductances of the rib cage and abdominal conductors 12, 14 to

signals suitable for further processing. The scaling amplifiers 24, 26 represent circuitry for calibrating the signals from the rib cage and abdomen, respectively, to reflect the relative contributions of the rib cage and abdomen to tidal volume. Once the scaling amplifiers 24, 26 are properly calibrated, the resulting signals may be summed, as by the summing amplifier 28 in FIG. 2, to yield a signal indicative of tidal volume. The output signal from the summing amplifier 28 as well as the output signals from the two scaling amplifiers 24 and 26 may then be displayed as on a graphic recorder 30 or a digital voltmeter 32. Optionally, a microprocessor 34 may be incorporated in the apparatus for summing the signals from the scaling amplifiers 24, 26 and/or further processing those signals for diagnostic purposes, all in accordance with techniques known to those of ordinary skill in the art. If the microprocessor 34 is used to sum the signals from the scaling amplifiers, the summing amplifier 28 may be eliminated.

The present invention is for an improved method for calibrating the signals from the rib cage and abdomen such that their sum produces a signal indicative of tidal volume. As is noted above, while various calibration techniques are known to those of ordinary skill in the art, all the known techniques possess drawbacks.

Turning to the calibration technique of the invention, from Equation A it is known that:

V = (KxRC)+(LxAB)

where V is total respiration volume or tidal volume, RC is the rib cage contribution to respiration volume as measured by the rib cage conductor and AB is the abdominal contribution to respiration volume as measured by the abdominal conductor. K and L are calibration factors for the rib cage and abdomen, respectively. Another way of expressing this relationship is:

V = Mx[(ZxRC)+AB] [EQUATION D]

where MxZ is equal to K and M is equal to L. It will be apparent that Equation D separates the calibration components into a preportionality factor Z and a scaling factor M. Using this approach, calibration may be viewed as a two step process. The first step is the determination of the correct proportionality factor Z satisfying Equation D, such that

V ~ (ZxRC)+AB [EQUATION E]

In other words, the proportionality factor Z defines the correct relative contributions of the rib cage (RC) and abdomen (AB) to tidal volume (V). Classically, determination of the proportionality factor Z is determined by an isovolume calibration technique in which the subject breathes against a closed airway i.e. with no volume movement at the mouth, whereby V=0. In other words, during an isovolume manuver, the only movement of volume is between the rib cage and abdomen compartments, i.e. pendelluft, since no air escapes through the mouth. Under these conditions, Equation D becomes:

0=(ZxRC) + AB [EQUATION F]

or

So, ~~By~~ recording the readings from the rib cage and abdomen conductors during the isovolume manuver, the proportionality factor Z can be determined from Equation G. Once Z is determined, the quantity (ZxRC)+AB can be calculated for any point in time from the recorded values of the rib cage and abdomen conductors. Since we know from Equation E that (ZxRC)+AB is always proportional to tidal volume V, a determination of that quantity provides a valuable diagnostic tool. For example, as those of ordinary skill in the art will appreciate, from this quantity obstructive and central apneas can be diagnosed, RC as a percent of tidal volume V can be calculated, and increases and decreases in relative tidal volume V can be assessed.

The difficulty with this approach is that an isovolume manuver requires breathing against a closed airway, which is not always practical, as in neo-natal and critical care applications.

If, on the other hand, the proportionality factor Z and hence the quantity(ZxRC)+AB is to be determined without an isovolume manuver, it would appear from Equation E that a measurement of tidal volume must be taken, otherwise there will be a single equation with two unknowns, namely, proportionality factor Z and tidal volume V.

In accordance with the present invention, this problem is solved as follows. The rib cage (RC) and abdomen (AB) signals are recorded for a large number of breaths during an initial baseline period. For example, 250 breaths may be measured during quiet breathing over a 10 minute interval. Actually, breathing during the baseline period need not be quiet, as long as it is steady state. For example, the baseline could be derived from breaths recorded during 10 minutes of exercise. During this baseline period, the uncalibrated signals from the rib cage (RC) and abdomen (AB) conductors are recorded. Referring to FIG. 3, for each of these signals, two values or breath "deltas" are calculated for each breath, ($_1$) being the difference between the signal at the beginning and end of inspiration, the other ($_2$) being the difference between the beginning and end of expiration. These delta values are then totaled separately for each signal. Assuming 250 breaths during baseline, and since there are two delta values for each breath, the total for each signal will be computed by adding 500 delta values. Where the delta values described above are proferred, it should be appreciated that the delta values are employed to provide a parameter indicative of the relative amplitude for each breath of the uncalibrated rib cage and abdomen signals taken during baseline. Accordingly, as used herein, the term delta values means any parameter of the uncalibrated rib cage and abdomen signals which provides this information.

If actual tidal volumes were also recorded during baseline, as by spirometry, and the deltas for tidal volume totaled and the mean determined, the following relationship would apply:

Mean SP = Mean RC + Mean AB [EQUATION H]

Where SP is actual tidal volume as determined, e.g. by spirometry. Since the mean values in Equation H are derived from uncalibrated signals, calibration factors are required if the lefthand side in Equation H is to equal the righthand side.

The standard deviations (SD) of the mean values for the tidal volume (SP) rib cage (RC) and abdomen (AB) signals can be calculated. Herein, these will be expressed, respectively, as SD (SP), SD (RC), and SD (AB). If tidal volume (SP) is constant for all breaths recorded during baseline, Equation H can still be computed and the standard deviation of tidal volume, SD (V), is 0.

This situation is analogous to Equation F which, as explained above, applies to the isovolume manuver where V=0. In particular, by considering the standard deviation of a constant tidal volume SD (V), which is also 0, the pendulluft occurring during normal breathing creates a situation analogous to the isovolume situation of Equation F, and taking the variance (Var) of both sides, yields:

Var (ZxRC) = Var (AB) [EQUATION J]

Where variance (Var) is equal to $(SD)^2$. Equation J may be expressed as

Z^2xVar (RC) = Var (AB) [EQUATION K]

By taking the square root of both sides

ZxSD (RC) = SD (AB) [EQUATION L]

Which yields

Z = SD (AB) / SD (RC) [EQUATION M]

It should be appreciated that the standard deviations of the means of the rib cage and abdomen signals is indicative of the average variability of those signals. Accordingly,1 any analysis that provides an indication of average variability of those signals may be used in lieu of computing standard deviations.

Put into other words, it will be apparent from Equation M that the proportionality constant Z for solution of Equation E can be calculated, assuming constant tidal volume breathing during baseline, from the ratio of the standard deviations of AB and RC in a manner analogous to the isovolume manuver, but without the requirement that the airway be blocked.

Of course, taking spirometry readings with a spirometer during baseline defeats an objective of the calibration technique in accordance with the invention, namely, to calibrate non-invasively.

However, baseline constant tidal volume assumption required to practice the calibration technique of the invention without invasively recording actual tidal volumes can be satisfied by removing wild points from the 500 delta values of AB and RC computed during baseline as by eliminating values outside of 1.5 standard deviations of the uncalibrated sum of the RC and AB components. With those delta values excluded, the remaining delta values for RC and AB are separately totaled, the means determined, and the standard deviations for the means calculated. The proportionality factor Z can then be calculated from Equation M.

Once the proportionality factor Z is known, the quantity (ZxRC)+ AB will always be proportional to actual tidal volume. See Equation E. This quantity can be continuously monitored on a real time basis from the real time rib cage and abdomen signals generated by the apparatus of FIG. 2. Preferably, this quantity is expressed as a percent of (ZxMean RC)+Mean AB where Mean RC and Mean AB are, respectively, the means of the totals of the uncalibrated RC and AB delta values generated at baseline, but exluding the wild points. This is sufficient for the bulk of diagnostic work, such as detecting obstructive and

central apneas, hypoapeneas, and variations in tidal volume, the latter being important as a diagnostic tool in a wide variety of disorders.

Referring to FIG. 2, assuming the scaling amplifiers have initially been set to unity gain, once the proportionality factor Z is determined, the scaling amplifier 24 for the rib cage is adjusted to Z. From Equation E, we then know that the sum of the signals from the scaling amplifiers at the output of the summing amplifier 28 will be preportional to tidal volume. This completes the calibration procedure.

While for most purposes a quantatitive determination of tidal volume is not necessary, quantitive calibration can be achieved once the proportionality factor Z is known. In particular, referring to Equation D, by taking a single measurement of actual tidal volume V, the scaling factor M can be calculated, since ZxRC and AB are available, respectively, at the output of the rib cage and abdomen scaling amplifiers. In other words, there is then only a single unknown in Equation D, the scaling factor M, which is calculated as:

$$M = V/[(ZxRC)+AB]. \qquad \text{[EQUATION N]}$$

One simple way to take a measurement of actual tidal volume is to simply have the subject inhale a known quantity of air, as from a syringe. Before the subject inhales, this quantity is input to the apparatus of FIG. 2 at the "spirometer", input. The microprocessor 34 can then perform the calculation of Equation N from the values of Z, RC and AB at the end of inspiration from the syringe.

The scaling factor M may be set in the FIG. 2 apparatus by multiplying the gain of the summing amplifier 28 by scaling factor M, whereupon the output of the summing amplifier will be a semi-quantatitive indication of tidal volume. The term semi-quantatitive is used because it has been determined that tidal volume computed in this fashion is ± 10% of actual tidal volume as

determined by spirometry.

Desirably, the accuracy of the proportionality factor Z is continuously monitored by repeatedly recalculating the proportionality factor at five minute intervals and printing out the resulting value. After the initial calibration procedure, the recalculated value for the proportionality factor Z during each subsequent five minute interval should be 1.0. In the event of a change in the position of the patient or other condition that varies the proportionality factor Z, that will exhibit itself as a reading of Z above or below 1.0. If the variations are too large, i.e. if Z is less than about .7 or greater than about 1.3, the calibration routine can be rerun. Suitable visual or audio alarms can be incoporated in the apparatus of FIG. 2 to indicate such excessive variations.

As noted above, the calibration technique in accordance with the present invention is currently utilized in connection with an apparatus for monitoring respiration sold by Nims, Inc., Miami Beach, Florida, under their model designation Respigraph TM. The Respigraph incorporates a microprocessor. Preferably, the microprocessor is programmed to carry out the calibration technique in accordance with the present invention. A program listing for a suitable program for carrying out the calibration function appears below in Table A. The program is in assembly language for a Z80 microprocessor as manufactured by Zylog, Inc.

FILE: QDC.ASM

```
 ;
 ;
        .IDENT  QDC
        .INSERT SP80.ASM
        .INSERT FPMAC.SRC
        .INSERT CALCOM.ASM
        .INSERT CKCOM.ASM
        .INSERT VTCCOM
        .INSERT SELCOM.ASM
        .INSERT VARCOM.CCC
        .INSERT GLQCOM
        .INSERT SYCOM
        .INSERT PKCOM
 ;
        .INSERT EFFCOM
        .INSERT SIOCOM
        .INSERT HRDCOM
        .EXTERN VALCOL,VALFND,TVON,SAVECL,LPON,LPOFF,TVOFF
        .EXTERN FIND
        .EXTERN DERIV5,PRTIME
        .EXTERN SAVECL
 ;
        .EXTERN VAL
 ;
 ;
        .ENTRY  QDC1,QDC2,LQDC1
        .ENTRY  BASE
 ;
        .EXTERN RTON,RTOF,RTICK
 ;
        .EXTERN QDCAL,SYST,ANSOUT

 ;
 ;
        .EXTERN SRTINIT,SRTPLOT,EXEC
        .EXTERN LABEL
        .EXTERN TDHE
        .EXTERN PTRUPD,GETP2,ROUND
 ;
 ;
        FINIT
 ;
 ;
 ;
QDC:
 ;
;THESE JUMPS MUST BE THE 1ST THINGS:
        JMP     QDC1
        JMP     QDC2
        JMP     VAL
        JMP     LQDC1
        JMP     ISOV1
        JMP     BASE
```

FILE: QDC.ASM

```
;
;
;
;
ISOV1:
        XRA     A
        STA     BSEFLG
        MVI     A,0FFH
        STA     ISOFLG
        MVI     A,0
        STA     WTFLG
        JMP     QDCCOL
;
;
;
;
BASE:
        MVI     A.0FFH
        STA     BSEFLG
        MVI     A,0FFH
        STA     WTFLG
        XRA     A
        STA     ISOFLG
        JMP     QDC3COL

;
;
;
QDC1:
        XRA     A
        STA     BSEFLG
        MVI     A,0
        STA     WTFLG
        STA     ISOFLG
        JMP     QDCCOL
;
LQDC1:
        XRA     A
        STA     BSEFLG
        MVI     A,0FFH
        STA     WTFLG
        XRA     A
        STA     ISOFLG
        JMP     QDCCOL
;
QDCCOL:
;
        XRA     A
        CMA
        STA     QUALFLG ;QUALITATIVE
        XRA     A
        STA     BSEFLG
;
```

FILE: QDC.ASM

```
;
QDC3COL:
;
;
;
;START THE DATA COLLECTION
;
;
        XRA     A
        STA     VALFLG
        STA     POS1    ;NOT IN SINGLE POSITION
        LXI     H,0
        SHLD    NBERS   ;# VALUES IN XVALUES & YVALUES
;
        LXI     H,0
        SHLD    TIME
        LXI     H,0
        SHLD    MAXCNT
;
        LDA     BSEFLG
        IF (.A,IS,ZERO) ;NOT COLLECTING BASELINE
;INIT THE TRANSDUCESERS
          MVI   A,10
          CALL  SYST
;THIS RESETS CALS TO 1 AND 1 SO AFTER THIS IS EXECUTED, ALL OTHER
; CALIBRATIONS ARE NULLIFIED
          XRA   A
          STA   CALTYPE
          STA   LASTCAL ;RIGHT NOW UNCALBRATED
          STA   GOODBASE        ;NO LONGER HAS GOOD BASELINE
;
          CALL  LPON
          FPRN  RES,RESPT
          CALL  LPOFF
        ENDIF
;
        CALL    SETUP
        CALL    SRTINIT ;INIT RT. PLOT
    LOOP
        CALL    SRTPLOT
;
        LDA     BFLG
        IF (.A,IS,NZERO)
;UPDATE # DELTAS AND ELAPSED TIME
          MVI   A,3
          STA   OPCODE
          CALL  ANSOUT
        ELSE
        LDA     SECFLG
        IF (.A,IS,NZERO)
          MVI   A,3
          STA   OPCODE
```

FILE: QDC.ASM

```
        CALL  ANSOUT
        LDA   FLSHFLG
        DCR   A
        STA   FLSHFLG
        IF (.A,IS,ZERO)
              LXI      H,TOPLFT+53
              LDA      BSEFLG
              IF (.A,IS,ZERO)
                LDA    ISOFLG
                IF (.A,IS,ZERO)
                 LXI   D,CLBMESS
                ELSE
                 LXI   D,ISOMESS
                ENDIF
              ELSE
                 LXI   D,BSEMESS
              ENDIF
              CALL     LABEL
              MVI      A,2
              STA      FLSHFLG
         ELSE
              LXI      H,TOPLFT+53
              LXI      D,BLANKS
              CALL     LABEL
         ENDIF

       ENDIF
       ENDIF
;
       LDA     GFLG     ;= 0FFH THEN CLOCK
                        ;STILL ON
       EXITIF(.A,IS,ZERO)
   ENDLOOP
;
;
; NOW DATA COLLECTION PHASE HAS BEEN COMPLETED
; MAXCNT HOLDS THE NUMBER OF MAX POINTS COLLECTED
;
;IRSRV USES CHANNEL SPBUFF FOR DETECTIONS
; SPMAX HOLDS THE DELTAS FROM SPBUFF
; RCMAX HOLDS THE DELTAS FROM RCBUFF
; ABMAX HOLDS THE DELTAS FROM ABBUFF
;
;CLEAR THE SCREEN
       CALL    TVON
       CALL    TVOFF

;
       LDA     BSEFLG
       IF (.A,IS,ZERO)
       LDA     ISOFLG
       IF (.A,IS,NZERO)        ;THIS WAS AN ISOVOLUME MANUEVER
         JMP   ISOCALC
```

FILE: QDC.ASM

```
        ENDIF
        ENDIF
;
        LHLD    MAXCNT
        LXI     D,3
        ORA     A
        DSBC    D
        IF (PSW,IS,CARRY)
;
          LDA   WTFLG
          IF (.A,IS,ZERO)
            MVI A,1
            STA OPCODE  ;NOT ENOUGH DELTAS
            CALL        ANSOUT
            MVI A,0
            STA OPCODE  ;PRINT MENU ON SCREEN
            CALL        ANSOUT
          ENDIF
            STC
           RET
        ENDIF
;
;
;
;THERE ARE 2*(MAXCNT -1) FLOATIND PT VALUES IN XVALUES
; AND YVALUES FOR THIS RUN
        LHLD    MAXCNT
        SHLD    NBERS   ;TOTAL # STORED
        CALL    QDCAL
;RETURN WITH CARRY SET IF BAD FOR ANY REASON
;
;
;ORA    A
;MVI    A,0
;STA    OPCODE  ;PRINT MENU ON SCREEN
;CALL   ANSOUT
        RET
;
;
;
;
ISOCALC:
        LDA     WRAPF
        IF (.A,IS,NZERO)        ;THEN 400 PTS AND RIPT PTS TO 1ST
                                ;DATA PT
          LXI   H,400
          SHLD  CNT
          LHLD  RIPT
          SHLD  ROPT
        ELSE
;TIME HOLDS # OF DATA POINTS AND 1ST PT AT OFFSET = 0
          LHLD  TIME
          SHLD  CNT
```

FILE: QDC.ASM

```
          LXI   H,0
          SHLD  ROPT
        ENDIF
;
        FFOA    0
        FSTA    XSUM
        FSTA    YSUM
        FSTA    XXSUM
        FSTA    XYSUM
        FSTA    XCNT
LOOP1:
        CALL    GETX
        CALL    GETY
        CALL    XYPAIR
;
        LHLD    ROPT
        LXI     B,RSIZE
        CALL    PTRUPD
        SHLD    ROPT
        DSKZ    CNT,LOOP1
;
        CALL    LSTFIT
        FLDA    SLOPE
        FABS
        FSTA    ABCAL
        FFOA    1
        FSTA    RCCAL
;PRINT IT ON SCREEN
        MVI     A,4
        STA     OPCODE
        CALL    ANSOUT
;
        CALL    SAVECL
        IF (PSW,IS,NCARRY)       ;THEN GOOD VALUES
           MVI  A,3      ;ISOV QUAL
           STA  CALTYPE
           MVI  A,0FFH
           STA  LASTCAL ;GOOD CALIBRATION
           XRA  A
           CMA
           STA  QUALFLG
           CALL LPON
           CALL PRTIME
           FPRN ISV,ISVPT
           CALL LPOFF
           ORA  A
        ENDIF

;
        RET
;
;
;
```

FILE: QDC.ASM

```
;
ISV:    .ASCIS  '
        QUALITATIVE ISOVOLUME CALIBRATION
                RCCAL = @D3
                ABCAL = @D3
'
ISVPT: .WORD    RCCAL,ABCAL
;
;
GETX:
        LXI     H,ABBUFF
        LDED    ROPT
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    XVAL
        FILA    XVAL
        FLOT
        FSTA    XVAL
        RET
;
GETY:
        LXI     H,RCBUFF
        LDED    ROPT
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    YVAL
        FILA    YVAL
        FLOT
        FSTA    YVAL
        RET
;
XYPAIR:
        FLDA    XVAL
        FLDB    XSUM
        FADD
        FSTA    XSUM
;
        FLDB    YVAL
        FLDA    YSUM
        FADD
        FSTA    YSUM
;
        FLDB    XVAL
        FLDA    XVAL
        FMUL
        FLDB    XXSUM
        FADD
        FSTA    XXSUM
;
```

FILE: QDC.ASM

```
        FLDB    XVAL
        FLDA    YVAL
        FMUL
        FLDB    XYSUM
        FADD
        FSTA    XYSUM
;
        FLDB    XCNT
        FFOA    1
        FADD
        FSTA    XCNT
        RET

LSTFIT:
        FLDA    XSUM
        FLDB    XSUM
        FMUL
        FPSH
;
        FLDA    XCNT
        FLDB    XXSUM
        FMUL
        FSWP
        FPOP
;
        FSUB
        FPSH
;
        FLDA    XSUM
        FLDB    YSUM
        FMUL
        FPSH
;
        FLDA    XCNT
        FLDB    XYSUM
        FMUL
        FSWP
        FPOP
;
        FSUB
        FSWP
        FPOP
        FDIV
        FSTA    SLOPE
        RET


;
QDC2:
;THIS CAN BE DONE AFTER EITHER A QDC1 (CALTYPE = 1/2)
; OR AFTER AN ISOVOLUME (CALTYPE = 3/4)
;
;IF CALTYPE = 0, THEN HAVEN'T CALIBRATED THE RC TO AB
```

FILE: QDC.ASM

```
        LDA     CALTYPE
        IF (.A,IS,ZERO)
          MVI   A,2
          STA   OPCODE
          CALL  ANSOUT
          RET
        ENDIF
;
;NOW COLLECT DATA AS IF VALIDATING
        CALL    VALCOL
;
        LHLD    MAXCNT
        LXI     D,2
        ORA     A
        DSBC    D
        IF (PSW,IS,CARRY)       ;THEN LESS THAN 2 BREATHS
          MVI   A,1
          STA   OPCODE
          CALL  ANSOUT
          MVI   A,0
          STA   OPCODE  ;PRINT MENU ON SCREEN
          CALL  ANSOUT
          RET
        ENDIF
;
;NOW FIND THE RATIOS OF SUM/KNOWN VOLUME
        CALL    VALFND
;RETURNS WITH AREG=# OF VALUES USED IN SUMMATION
;
        FSTA    FCNT
;
;
;NOW XVALUES HOLDS ALL OF THE RATIOS, XSUM HOLDS SUM OF ALL XVALUES
;XXSUM HOLS SUM OF SQUARES OF ALL XVAUES, AND FCNT HOLS THE NUMBER
;OF VALUES USED IN THE SUMMATION
;
;COMPUTE THE MEAN RATIO
        FLDB    XSUM
        FLDA    FCNT
        FDIV
        FSTA    MEAN
;;NOW KNOW THAT SUM NEEDS TO BE MULTIPLIED BY 1/MEAN, SO
; RCCAL = CURRENT RC GAIN (RCGNF) * 1/MEAN
; ABCAL = CURRENT AB GAIN (ABGNF) * 1/MEAN
        FFOA    1
        FATB
        FLDA    MEAN
        FDIV
        FLDB    RCGNF
        FMUL
        FSTA    RCCAL
;
        FFOA    1
```

FILE: QDC.ASM

```
        FATB
        FLDA    MEAN
        FDIV
        FLDB    ABGNF
        FMUL
        FSTA    ABCAL
;
          MVI   A,4
          STA   OPCODE
          CALL  ANSOUT
;
        CALL    SAVECL
        IF (PSW,IS,NCARRY)       ;THEN GOOD
          CALL  LPON
          CALL  PRTIME
          FPRN  VL2,VL2PT
          CALL  LPOFF
          LXI   H,0
          SHLD  NBERS
          XRA   A
          STA   QUALFLG ;NOT QUALITATIVE, IT IS QUANTITATIVE CAL
;
;
        LDA     CALTYPE
        IF (.A,LT,3)     ;THEN QDC METHOD
           MVI  A,2      ;NOW ITS QDC QUANT
            STA  CALTYPE
           MVI  A,0FFH
            STA  LASTCAL ;GOOD CAL
        ELSE             ;ISOVOLUME METHOD
           MVI  A,4
            STA  CALTYPE ;NOT ITS ISOV QUANT
           MVI  A,0FFH
            STA  LASTCAL ;GOOD CAL
        ENDIF
;
;
;
;MULT THE CURRENT VALUE OF VTLIMIT BY 1/MEAN SO WILL BE SCALED OK
; NOTE: VTLIMIT IS INITIALLY SET WHEN DOING QDC1
;
;THIS IS FOR INITIALLIZING THE HYPOPNEA VOLUME FOR THE 1ST 5 MINUTES:
          FLDB  VTLIMIT
          FLDA  MEAN
          FDIV
          FSTA  VTLIMIT
;***************************************************************
;PROBLEM: WHAT IF DID ISOVOLUME BEFORE HERE, THEN VTLIMIT WAS NOT
;          EVER INITITALIZED ????
;***************************************************************
        ENDIF

;
```

FILE: QDC.ASM

```
;MVI    A,0
;STA    OPCODE  ;PRINT MENU ON SCREEN
;CALL   ANSOUT
        RET
;;
;
VL2:    .ASCIS  '
   QUANTITATIVE CAL FACTORS
   RC CAL = 3D3
   AB CAL = 3D3
  '
;
VL2PT:
        .WORD   RCCAL,ABCAL
;
;
;NOTE:  MCA VALUES OF RCINVOL, ABINVOL, AND SMVOL WILL
;       BE STORED BEGINNING AT ADDR = XVALUES
;       XVALUES + YVALUES = 1600 BYTES
;       I WILL STORE UP TO 1500 BYTES
;
;       == > 500 DELTAS = 250 INSP DELTAS * 6 BYTES
;             = 1500 BYTES
;       MCAADDR = ADDRESS OF NEXT TO STORE
;
;
;
;
SETUP:
;
;THIS IS ONLY USED WHEN CALIBRATING QDC METHOD
;
;SETUP THE CLOCK
;
;SAMPLE AT 20 PTS PER SEC
        PUSH    H
; INIT REAL-TIME BUFFER POINTERS
; MODIFIED  09-24-81
;FOR PEAK FLOWS:
        LXI     H,DLTIMES
        SHLD    TMPTR
        LXI     H,0
        SHLD    TTPOS
        SHLD    TTNEG
        SHLD    TEMPK
        SHLD    TTPTM
        SHLD    TTNTM
        SHLD    PKTIME
;
        LXI     H,0
        SHLD    DLTIPTR ;OFFSET TO STORE NEXT DELTA
        XRA     A
        STA     DLTFULL ;DELTA RING BUFFER NOT FULL YET
```

FILE: QDC.ASM

```
        CMA
        STA     FSTMN
;
        LXI     H,XVALUES       ;WILL USE THIS BUFFER TO
        SHLD    MCAADDR         ;MCA VALUES
;
        LXI     H,0
        SHLD    SPTEMP
;
        XRA     A
        STA     FRSTMX  ;1ST MAX NOT FOUND
;
        LXI     H,TMBUFF
        MVI     M,0
        INX     H
        MVI     M,0

;
        MVI     A,2
        STA     FLSHFLG
;
;
        XRA     A
        STA     WRAPF
        STA     SECFLG
        CMA
        STA     BFLG
        LXI     H,0
        SHLD    ELPTM
        SHLD    ELPMIN
        SHLD    SECONDS
;
        LXI     H,0
        SHLD    RIPT
        SHLD    ROPT
        SHLD    ODRIPT
          LXI   H,0
          SHLD  TIME
; INIT VARIABLES FOR PICKING MAX AND MINS
        XRA     A
        STA     MAXB
        STA     PTF     ;START BY LOOKING FOR MAX PT
        STA     SLOPEF  ;INIT MAX NOT FOUND
;
        XRA     A
        STA     INTFLG
        CMA
        STA     GFLG    ;INDICATES CLOCK ON
;
        LXI     H,IRSRV
        CALL    RTON    ;TURN ON CLOCK
;
        POP     H
```

FILE: QDC.ASM

```
        RET
;
;
;
CLKSTP:
        ;STOP DATA COLLECTION
        ;TURN CLOCK OFF
;
;MODIFIED 09-24-81
;
        CALL    RTOF    ;TURN OFF CLOCK
        XRA     A
        STA     GFLG
        POP     D
        POP     H
        POP     B
        POP     PSW
        RET
;
;
;
;
;
IRSRV:
;
; INTERRUPT SERVICE ROUTINE
;
        PUSH    PSW
        PUSH    B
        PUSH    H
        PUSH    D
        CALL    RTICK   ;SERVICE INTERRUPT
        LDA     INTFLG
        IF (.A,IS,NZERO)        ;THEN INTERRUPT INTERRUPT
          NOP
        ELSE
          CMA
          STA   INTFLG  ;SET FLAG
        ENDIF
;
;
        LHLD    ELPTM
        INX     H
        SHLD    ELPTM
        LDED    SFREQ
        CALL    TDHE
        IF (PSW,IS,ZERO)        ;THEN 1 SECON
          LXI   H,0
          SHLD  ELPTM
          LHLD  SECONDS
          INX   H
          SHLD  SECONDS
          XRA   A
```

FILE: QDC.ASM

```
          CMA
          STA   SECFLG
          LXI   D,60
          CALL  TDHE
          IF (PSW,IS,ZERO)        ;THEN 1 MINUTE
            LXI H,0
            SHLD         SECONDS
            LHLD         ELPMIN
            INX H
            SHLD         ELPMIN
;IF COLLECING BASELINE: THEN STOP AT 5 MINUTES
            LDA BSEFLG
            IF (.A,IS,NZERO)
                LXI      D,5
                LHLD     ELPMIN
                CALL     TDHE
                IF (PSW,IS,ZERO)
                        JMP      CLKSTP
                ENDIF
             ELSE
;
;
;WHILE CALIBRATING: IF REACH 10 MINUTES BEFORE 500 DELTAS,
; THEN AUTOMATICALLY STOP
              LXI        D,10
              LHLD       ELPMIN
              CALL       TDHE
              IF (PSW,IS,ZERO)  ;HAVE REACHED 10 MINUTES
                JMP      CLKSTP
              ENDIF
            ENDIF
;
          ENDIF
        ENDIF
;
;
;
;
;ALWAYS COLLECT RC INTO RCBUFF,
;               AB INTO ABBUFF,
;
;NOTE: ALWAYS USES DATA IN SPBUFF FOR DETECTION
;
        LHLD    RCAD    ;RIB CAGE VALUE
        MOV     A,H
        CMA
        ANI     0FH
        MOV     H,A
        MOV     A,L
        CMA
        MOV     L,A
        SHLD    DATA
        SHLD    RCV
```

FILE: QDC.ASM

```
;
        LHLD    RIPT
        LXI     D,RCBUFF
        CALL    PRNG
;
;
        LHLD    ABAD    ;ABDOMEN VALUE
        MOV     A,H
        CMA
        ANI     0FH
        MOV     H,A
        MOV     A,L
        CMA
        MOV     L,A
        SHLD    DATA
        SHLD    ABV
;
        LHLD    RIPT
        LXI     D,ABBUFF
        CALL    PRNG
;
; SUM INTO SPBUFF--- TO PICK OFF BREATHS
        LHLD    RCV
        LDED    ABV
        DAD     D
        SHLD    DATA
;
        LHLD    RIPT
        LXI     D,SPBUFF
        CALL    PRNG
;
;
;
;
;
;INCREMENT RIPT FOR NEXT TIME
;
        LHLD    TIME
        INX     H
        SHLD    TIME
        SHLD    DATA
        LHLD    RIPT
        LXI     D,TMBUFF
        CALL    PRNG
;
        LHLD    RIPT
        SHLD    ODRIPT
;
        LXI     B,RSIZE
        LHLD    RIPT
        CALL    PTRUPD
        SHLD    RIPT
```

FILE: QDC.ASM

```
;
        LDA     WRAPF
        IF (.A,IS,ZERO) ;SEE IF RIPT RESET TO 0
          LXI   D,0
          LHLD  RIPT
          CALL  TDHE
          IF (PSW,IS,ZERO)
            MVI A,0FFH
            STA WRAPF
          ENDIF
        ENDIF
;
        LDA     BSEFLG
        IF (.A,IS,ZERO)
        LDA     ISOFLG
        IF (.A,IS,NZERO)        ;THEN NO PEAK DETECTION
          JMP   EXIT
        ENDIF
        ENDIF
;
;
        LDA     SLOPEF
        IF (.A,IS,ZERO) ;THEN INIT POINTS NOT COLLECTED YET
          CALL  GETP2   ;RETURNS C IF < 5 PTS IN BUFFER
                        ;THIS JUST MAKES SURE EXTRA
                        ;POINTS IN BUFFER
          JC    EXIT    ;NOT ENOUGH POINTS IN BUFFER
;
;NOTE: GETP2 INITIALLIZES ROPT TO LINE UP WITH DERIV STUFF
;SKIP 1ST 3 POINTS IN BUFFER
;  LXI H,6      ;OFFSET POINTING TO POINT 4
;  SHLD         ROPT

;
;
          MVI   A,0FFH
          STA   SLOPEF
        ENDIF
;
;
;
;
        CALL    DERIV5
;
;
;*********************************
;
;MUST ADD THE CODE TO DO PEAK DETECTION
;HERE TOO !!
;
        LDA     FRSTMX
        IF (.A,IS,ZERO) ;HAVE NOT FOUND 1ST MAX POINT
;
```

FILE: QDC.ASM

```
;
;
            LHLD ROPT
            CALL FIND
            IF (PSW,IS,NCARRY)    ;NOT A MAX
                 JMP      OUTER
            ENDIF
;HAVE 1ST MAX
            LDA  FRSTMX
            CMA
            STA  FRSTMX
            SHLD SPTEMP  ;TEMP CRITICAL POINT
            SDED RCTEMP
            SBCD ABTEMP
            LDA  PTF
            CMA
            STA  PTF     ;NOW LOOK FOR MIN
            JMP  OUTER
        ENDIF
;
;
        LHLD     ROPT
        CALL     FIND
        IF (PSW,IS,CARRY)
          SHLD  SPVALUE
          SDED  RCVALUE
          SBCD  ABVALUE
          LDA   PTF
          IF (.A,IS,ZERO)        ;THIS IS A MAX POINT
                 LHLD     RCVALUE
                 SHLD     RCMXVAL
                 LHLD     ABVALUE
                 SHLD     ABMXVAL
;
                 CALL     DLTSTORE
;ONLY STORE THE MCA VARIABLES AT A MAX (ONLY WANT FOR INSP)
                 CALL     MCASTORE
;
;
;IF DLTIPTR = 1000, THEN EXIT
                 LHLD     DLTIPTR
                 LXI      D,1000
                 CALL     TDHE
                 IF (PSW,IS,ZERO)
                   MVI    A,0FFH
                   STA    DLTFULL
                   LXI    H,0
                   SHLD   DLTIPTR
                   JMP    CLKSTP
                 ENDIF
          ELSE            ;THIS IS MIN POINT
                 LHLD     RCVALUE
                 SHLD     RCMNVAL
```

FILE: QDC.ASM

```
                LHLD    ABVALUE
                SHLD    ABMNVAL
                LDA     FSTMN
                IF (.A,IS,NZERO)        ;THIS IS THE 1ST MIN, DO NOT STORE
                  LDA   FSTMN
                  CMA
                  STA   FSTMN
                ELSE    ;STORE THE DELTA
                  CALL  DLTSTORE
;
;
;IF DLTIPTR = 1000, THEN EXIT
                  LHLD  DLTIPTR
                  LXI   D,1000
                  CALL  TDHE
                  IF (PSW,IS,ZERO)
                    MVI A,0FFH
                    STA DLTFULL
                    LXI H,0
                    SHLD        DLTIPTR
                    JMP CLKSTP
                  ENDIF
                ENDIF
;
          ENDIF
          LDA   PTF
          CMA
          STA   PTF
        ENDIF
;
;********************************
OUTER:
;
;UPDATE ROPT FOR NEXT TIME
;
        LHLD    ROPT
        LXI     B,RSIZE
        CALL    PTRUPD
        SHLD    ROPT

;
EXIT:
; LOOK FOR ENTER
;
        CALL    CSTS
        IF (PSW,IS,NZERO)
          CALL  CINP
          IF (.A,EQ,0DH)        ;IF ENTER
            JMP         CLKSTP
          ENDIF
        ENDIF
;
        XRA     A
```

FILE: QDC.ASM

```
        STA     INTFLG
        POP     D
        POP     H
        POP     B
        POP     PSW
        RET
;
;
MCASTORE:
        LHLD    MCAADDR
        LDED    RCINVOL
        MOV     M,E
        INX     H
        MOV     M,D
        INX     H
        LDED    ABINVOL
        MOV     M,E
        INX     H
        MOV     M,D
        INX     H
        LDED    SMVOL
        MOV     M,E
        INX     H
        MOV     M,D
        INX     H
        SHLD    MCAADDR
        RET
;
;
;
DLTSTORE:
                LHLD    RCMXVAL
                LDED    RCMNVAL
                ORA     A
                DSBC    D
;HL = INSP VOLUME       ;RC
                SHLD    RCVALUE ;DELTA RC
                LHLD    DLTIPTR ;OFFSET TO STORE
                LXI     D,RCDATA
                DAD     D
                LDED    RCVALUE
                MOV     M,E
                INX     H
                MOV     M,D
;
                LHLD    ABMXVAL
                LDED    ABMNVAL
                ORA     A
                DSBC    D
;HL = INSP VOLUME       ;AB
                SHLD    ABVALUE ;DETLA AB
                LHLD    DLTIPTR ;OFFSET TO STORE
                LXI     D,ABDATA
```

FILE: QDC.ASM

```
                DAD     D
                LDED    ABVALUE
                MOV     M,E
                INX     H
                MOV     M,D
                LHLD    DLTIPTR
                INX     H
                INX     H
                SHLD    DLTIPTR
                LHLD    MAXCNT
                INX     H
                SHLD    MAXCNT
                XRA     A
                CMA
                STA     BFLG
;STORE THE TIMES
        LHLD    TMPTR
        LXI     D,DLTEND
        CALL    TDHE
        IF (PSW,IS,ZERO)        ;NO ROOM
          RET
        ENDIF
;
        LHLD    TMPTR
        LDED    CPTIME  ;TIME OF THE CP
        MOV     M,E
        INX     H
        MOV     M,D
        INX     H
        LDED    PKVALUE ;TIME OF THE PEAK FLOW
        MOV     M,E
        INX     H
        MOV     M,D
        INX     H
        SHLD    TMPTR   ;FOR NEXT TIME
                RET
;
;
PRNG:
;
;HL HOLDS THE RING INPUT PTR
;DE HOLDS ADDR OF RING
;
        DAD     D
        LDED    DATA
        MOV     M,E
        INX     H
        MOV     M,D
        RET
;
ISOMESS:        .ASCIS  'Isovolume'
;
BSEMESS:        .ASCIS  'Baseline'
```

FILE: QDC.ASM

```
;
CLBMESS:        .ASCIS  'Calibrating'
BLANKS:         .ASCIS         '
;
RES:    .ASCIS  '
AT 0I:0I:0I     Cal factors reset to 1 and 1
'
RESPT: .WORD    HOUR,MIN,SEC
;
        .EXTERN QDCOM
        .LOC    QDCOM
;
MAXB:   .BLKB   1
RCCU:   .BLKB   2
ABCU:   .BLKB   2
SPCU:   .BLKB   2
RCV:    .BLKB   2
ABV:    .BLKB   2
MEAN:   .BLKB   4
FCNT:   .BLKB   4
;
FRSTMX:         .BLKB   1
RCMXVAL:        .BLKB   2
RCMNVAL:        .BLKB   2
ABMXVAL:        .BLKB   2
ABMNVAL:        .BLKB   2
FSTMN: .BLKB    1
FLSHFLG:        .BLKB   1
ISOFLG:         .BLKB   1
XCNT:   .BLKB   4
QDCEXTRA:       .BLKB   9       ;EXTRA LOCS
        .RELOC
        .END    QDC

;
;
;
;
```

FILE: QDCAL.ASM

```
        .IDENT  QDCAL
        .INSERT FPMAC.SRC
        .INSERT SP80
        FINIT
        .INSERT VTCCOM
        .INSERT CALCOM
        .INSERT OLQCOM
        .INSERT CKCOM
        .INSERT VARCOM.CCC
        .INSERT SYCOM
        .INSERT EFFCOM
        .INSERT SIOCOM
        .INSERT QD1.ASM
        .INSERT PKCOM
;
        .EXTERN CMPSTATS
;
        .ENTRY  QDCAL
        .EXTERN TDHE,ROUND
        .EXTERN SAVECL,ANSOUT,LPON,LPOFF
        .ENTRY  V2        ;SO CAN LOOK AT MAP!
        .EXTERN PRTIME
        .EXTERN WTSAVECL
;
        .EXTERN TVON,TVOFF
;
;
;
QDCAL:
        LDA     BSEFLG
        IF (.A,IS,NZERO)        ;BASELINE
           JMP  BCOMP
        ENDIF

;ENTERED HERE, THEN IN CALIBRATE MODE (NOT LONG TERM)
;
        CALL    CMPSTATS
        RC                      ;CARRY SET IF BAD CAL
                                ;BECAUSE NOT ENOUGH DATA COLLECTED
;
;
;ABCAL = RCSTD / ABSTD
        FLDB    RCSTD
        FLDA    ABSTD
        FDIV
        FSTA    ABCAL
;RCCAL = 1
        FF0A    1
        FSTA    RCCAL
;
;
;MUST STORE THE GAINS, BECAUSE RESCALE ASSUMES SO !!
        LDA     WTFLG
```

FILE: QDCAL.ASM

```
        IF (.A,IS,ZERO) ;WANT TO PRINT ERROR CODE IF BAD
          CALL  SAVECL
        ELSE
          CALL  WTSAVECL
        ENDIF
        IF (PSW,IS,CARRY)        ;THEN BAD CALS
          MVI   A,0       ;NO GOOD CALIBRATION (WHEN BEGAN THIS RUN, RESET
          STA   CALTYPE ;CALS TO 1 AND 1
          MVI   A,0
          STA   LASTCAL ;NO GOOD CAL
          STA   GOODBASE         ;NO GOOD BASELINE NOW
;PRINT OUT WHAT THE BAD CALS WERE AND THE STDS
          CALL  BDCALS
          STC             ;BAD CALS
          RET
        ENDIF
;
;
;NOW MUST USE THE MEAN VT MEASURED TO SCALE THE CAL FACTORS SO
; MEAN VT = VTMX/10
        CALL    RESCALE
;
        LDA     WTFLG
        IF (.A,IS,ZERO)
          MVI   A,4
          STA   OPCODE
          CALL  ANSOUT  ;DISPLAY THE CALS ON THE MONITOR
        ENDIF
;
        LDA     WTFLG
        IF (.A,IS,ZERO) ;WANT TO PRINT ERROR CODE IF BAD
          CALL  SAVECL
        ELSE
          CALL  WTSAVECL
        ENDIF
        IF (PSW,IS,NCARRY)       ;THEN GOOD CALS
          CALL  LPON
          CALL  PRTIME
          FPRN  V1,V1PT
          CALL  LPOFF
          CALL  CMPMCA  ;COMPUTE MCA/VT
          CALL  LPON
          FPRN  V2,V2PT
          CALL  PRTHYP
          CALL  LPOFF
          MVI   A,1       ;QDC QUAL
          STA   CALTYPE
          MVI   A,0FFH
          STA   LASTCAL
          ORA   A         ;GOOD CALS
        ELSE
          MVI   A,0       ;NO GOOD CALIBRATION (WHEN BEGAN THIS RUN, RESET
          STA   CALTYPE ;CALS TO 1 AND 1
```

FILE: QDCAL.ASM

```
          MVI    A,0
          STA    LASTCAL ;NO GOOD CAL
          STA    GOODBASE        ;NO GOOD BASELINE NOW
;PRINT OUT WHAT THE BAD CALS WERE AND THE STDS
;
          CALL   BDCALS
          FFOA   1
          FSTA   RCCAL
          FSTA   ABCAL
          CALL   CMPMCA   ;COMPUTE MCA/VT
          CALL   LPON
          FPRN   V2,V2PT
          CALL   PRTHYP
          LXI    H,STARS
          CALL   TXTYP
          CALL   LPOFF
;
          STC             ;BAD CALS
        ENDIF
        RET
;
;
;
;
BDCALS:
;
;
          CALL   LPON
          LXI    H,STARS
          CALL   TXTYP
          CALL   PRTIME
          FPRN   BADC,BADPT
          CALL   LPOFF
        RET
;
;
;
PRTHYP:
        FPRN     HYP,HYPPT
          LDA    QUALFLG
          IF (.A,IS,NZERO)       ;QUAL
            LXI H,RHYP
          ELSE            ;QUANT
            LXI H,AHYP
          ENDIF
        CALL     TXTYP
        RET
;

BCOMP:
;THIS COMPUTE MEAN VT AND IF ISOV WAS QUALITATIVE, CALTYPE = 3,
; THEN IT SCALES IT TO VTMAX/10
;
```

FILE: QDCAL.ASM

```
        CALL    CMPSTATS
        IF (PSW,IS,ZERO)          ;NOT ENOUGH DATA
           XRA  A
           STA  GOODBASE          ;NOT A GOOD BASELINE
           STC
           RET
        ENDIF
;
        CALL    RESCALE ;THIS WILL CHANGE VALUE OF RCCAL AND ABCAL
;
        LDA     CALTYPE
        IF (A,EQ,3)     ;ISOV QUAL
;
;SAVE CALS
;NOW MUST USE THE MEAN VT MEASURED TO SCALE THE CAL FACTORS SO
; MEAN VT = VTMX/10
          CALL  WTSAVECL
;
;
          IF (PSW,IS,NCARRY)      ;THEN GOOD CALS
            MVI A,5      ;ISO-QUAL WITH BASELINE
            STA CALTYPE
            MVI A,0FFH
            STA LASTCAL ;GOOD CAL
            CALL         LPON
            CALL         PRTIME
            FPRN         BS1,BS1PT
            CALL         LPOFF
            CALL         CMPMCA   ;COMPUTE MCA/VT
            CALL         LPON
            FPRN         V2,V2PT
          CALL  PRTHYP
            CALL         LPOFF
            MVI A,0FFH
            STA GOODBASE          ;GOOD BASELINE
            ORA A        ;GOOD CALS
           ELSE
            FFOA         1
            FSTA         RCCAL
            FSTA         ABCAL
            CALL         CMPMCA   ;COMPUTE MCA/VT
            CALL         LPON
            LXI H,STARS
            CALL         TXTYP
            CALL         PRTIME
            FPRN         BSBAD,BSBPT
            FPRN         V2,V2PT
          CALL  PRTHYP
            LXI H,STARS
            CALL         TXTYP
            CALL         LPOFF
            MVI A,0
            STA GOODBASE          ;BAD BASELINE
```

FILE: QDCAL.ASM

```
            STC             ;BAD CALS
          ENDIF
        ELSE      ;ALREADY DID QUANT ISOV
        IF (.A.EQ.5)
           MVI   A,6        ;ISO QUANT WITH BASELINE
           STA   CALTYPE
            CALL            LPON
            CALL            PRTIME
            FPRN            BS3,BS3PT
            CALL            LPOFF
;CALS DO NOT CHANGE
            FFOA            1
            FSTA            RCCAL
            FSTA            ABCAL
            CALL            CMPMCA   ;COMPUTE MCA/VT
            CALL            LPON
            FPRN            V2,V2PT
          CALL   PRTHYP
            CALL            LPOFF
            MVI A,0FFH
            STA GOODBASE            ;GOOD BASELINE
            ORA A           ;GOOD CALS
        ELSE
        IF (.A.EQ.7)        ;TYPED IN CALS, QUANT, JUST GETTING BASELINE STUFF
          LDA    QUALFLG
          IF (.A,IS,ZERO)
            CALL            LPON
            CALL            PRTIME
            FPRN            BS7,BS7PT
            CALL            LPOFF
;CALS DO NOT CHANGE
            FFOA            1
            FSTA            RCCAL
            FSTA            ABCAL
            CALL            CMPMCA   ;COMPUTE MCA/VT
            CALL            LPON
            FPRN            V2,V2PT
          CALL   PRTHYP
            CALL            LPOFF
            MVI A,0FFH
            STA GOODBASE            ;GOOD BASELINE
            ORA A           ;GOOD CALS
          ELSE              ;TYPED IN CALS,QUAL SO WILL CHANGE CALS
;**
;
;SAVE CALS
;NOW MUST USE THE MEAN VT MEASURED TO SCALE THE CAL FACTORS SO
; MEAN VT = VTMX/10
          CALL  WTSAVECL
;
;
          IF (PSW,IS,NCARRY)      ;THEN GOOD CALS
            CALL            LPON
```

FILE: QDCAL.ASM

```
                CALL            PRTIME
                FPRN            V7,V7PT
                CALL            LPOFF
                CALL            CMPMCA   ;COMPUTE MCA/VT
                CALL            LPON
                FPRN            V2,V2PT
              CALL   PRTHYP
                CALL            LPOFF
                MVI A,0FFH
                STA GOODBASE             ;GOOD BASELINE
                ORA A           ;GOOD CALS
               ELSE
                FFOA            1
                FSTA            RCCAL
                FSTA            ABCAL
                CALL            CMPMCA   ;COMPUTE MCA/VT
                CALL            LPON
                CALL            PRTIME
                FPRN            BSBAD,BSBPT
                FPRN            V2,V2PT
              CALL   PRTHYP
                CALL            LPOFF
                MVI A,0
                STA GOODBASE             ;BAD BASELINE
                STC             ;BAD CALS
              ENDIF
      ;**
              ENDIF
            ENDIF
            ENDIF

            ENDIF
            RET
      ;
      ;
      ;
      CMPMCA:

      ;
      ;
      ;COMPUTE MEAN MCA/VT
      ;MUST REMEMBER THAT ALL RC VALUES MUST BE  MULT BY RCCAL
      ; AND ALL AB VALUES MUST BE MULT BY ABCAL
      ;
      ;NOTE: WILL NOT BE ABLE TO COMPUTE MCA/VT THE CLEAN WAY OF USING
      ;      THEN SUM OF THE SUM'S DERIV BECAUSE THE THE CAL FACTOR PROBLEM
      ;      SO WILL HAVE TO DIVIDE BY RC DELTA * RCCAL + AB DELTA * ABCAL
            LXI     H,XVALUES
            SHLD    ADDR1
            LDA     DLTFULL
            IF (.A,IS,NZERO)         ;FULL
              LHLD  DLTIPTR
              SHLD  OFFSET
```

FILE: QDCAL.ASM

```
        ELSE
          LXI   H,0
          SHLD  OFFSET
        ENDIF

        FFOA    0
        FSTA    VTSUM
        FSTA    MCASUM
        FSTA    XCNT
LOOP
        LHLD    ADDR1
        LDED    MCAADDR
        CALL    TOHE
        IF (PSW,IS,ZERO)
          RET
        ENDIF
;
;GET MCA VALUE
        LHLD    ADDR1
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCMCA
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABMCA
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    SMMCA
        INX     H
        SHLD    ADDR1
;
        FILA    RCMCA
        FLOT
        FLDB    RCCAL
        FMUL
        FPSH
        FILA    ABMCA
        FLOT
        FLDB    ABCAL
        FMUL
        FATB
        FPOP
        FADD
        FATB
        FFOA    15      ;BECAUSE OF 9 PT DERIV 60
                        ;/4 BECAUSE OF DIVISION WHEN COLLECTED
        FDIV
        FLDB    CCS
```

FILE: QDCAL.ASM

```
        FMUL
        FSTA    MCAVALUE
;
;GET VT VALUE
        LHLD    OFFSET
        LXI     D,RCDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    FRC
;
        LHLD    OFFSET
        LXI     D,ABDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    FAB
;
        FILA    FRC
        FLOT
        FLDB    RCCAL
        FMUL
        FPSH
        FILA    FAB
        FLOT
        FLDB    ABCAL
        FMUL
        FATB
        FPOP
        FADD
        FLDB    CCS
        FMUL
        FSTA    VTVALUE
;
;
;MCASUM = SUM OF MCAVALUE/VTVALUE
;
        FLDB    MCAVALUE
        FLDA    VTVALUE
        FDIV
;IF < 1, THEN MAKE = 1
        FPSH
        FATB
        FFOA    1
        FSUB
        FTST    AREG,LT
        IF (PSW.IS,ZERO)
          FPOP
          FFOA  1
        ELSE
          FPOP
```

FILE: QDCAL.ASM

```
        ENDIF
;
        FLDB    MCASUM
        FADD
        FSTA    MCASUM
;
        FLDB    VTVALUE
        FLDA    VTSUM
        FADD
        FSTA    VTSUM

        FLDB    XCNT
        FFDA    1
        FADD
        FSTA    XCNT
;
        LHLD    OFFSET
        INX     H
        INX     H
        SHLD    OFFSET
        LDED    DLTIPTR
        CALL    TDHE
        IF (PSW,IS,ZERO)
          RET
        ENDIF
;
;NOW OFFSET POINTS TO EXP DELTA--SKIP IT !!
;
        LHLD    OFFSET
        INX     H
        INX     H
        SHLD    OFFSET
        LDED    DLTIPTR
        CALL    TDHE
        IF (PSW,IS,ZERO)
          RET
        ENDIF
ENDLOOP
;
;
        FLDB    VTSUM
        FLDA    XCNT
        FDIV
        FSTA    VTVALUE ;MEAN VT
;
        FLDB    MCASUM
        FLDA    XCNT
        FDIV
        FSTA    MCAVT   ;MEAN MCA/VT
;
;
;MEAN MCA/VT = MEAN MCA / MEAN VT
;
```

FILE: QDCAL.ASM

```
;       FLDB    MCAVALUE
;       FLDA    VTVALUE
;       FDIV
;;IF < 1, THEN SET = 1
;       FPSH
;       FATB
;       FFOA    1
;       FSUB
;       FTST    AREG.LT
;       IF (PSW,IS,ZERO)
;         FPOP
;         FFOA  1
;       ELSE
;         FPOP
;       ENDIF
;       FSTA    MCAVT
;
;
;
;COMPUTE THE MEAN VALUE OF % TIME TO PEAK INSP FLOW
; AND MEAN VALUE OF  % TIME TO PEAK EXP FLOW
        LHLD    TMPTR
        LXI     D,DLTIMES
        CALL    TDHE
        IF (PSW,IS,ZERO)          ;NONE
          LXI   H,0
          SHLD  PCNUMBERS
          RET
        ENDIF
;
        FFOA    0
        FSTA    PKISUM
        FSTA    PKESUM
        FSTA    TISUM
        LXI     H,0
        SHLD    PCNUMBERS
        LXI     H,DLTIMES
        SHLD    ADDR1
LOOP
;MAKE SURE THAT ADDR1+10< TMPTR
        LHLD    ADDR1
        LXI     D,10
        DAD     D
        LDED    TMPTR
        ORA     A
        DSBC    D
        IF (PSW,IS,NCARRY)        ;THEN ALL DATA NOT THERE
          RET
        ENDIF
;
;ASSUME THAT ADDR1 PTS TO MIN1
        LHLD    ADDR1
        MOV     E,M
```

FILE: QDCAL.ASM

```
        INX     H
        MOV     D,M
        SDED    TMIN1
;GET  PKE, MAX, PKI, MIN2 VALUES
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    PKE       ;FOR LAST BREATH
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    TMAX
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    PKI
        INX     H
        SHLD    ADDR1     ;SO NEXT TIME ADDR1 PTS TO MIN1 OF NEXT
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    TMIN2
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    PKE       ;FOR THIS BREATH
;% T TO PEAK INSP FLOW = (PKI-TMIN1) / (TMAX-TMIN1) * 100%
        LHLD    TMAX
        LDED    TMIN1
        ORA     A
        DSBC    D
        SHLD    TTEMP
        LHLD    PKI
        LDED    TMIN1
        ORA     A
        DSBC    D
        SHLD    TT2EMP
        FILA    TT2EMP
        FLOT
        FATB
        FILA    TTEMP
        FLOT
        FDIV
        FATB
        FFOA    100
        FMUL
;% T TO PEAK INSP FLOW
        FLDB    PKISUM
        FADD
```

FILE: QDCAL.ASM

```
        FSTA    PKISUM
;% T TO PEAK EXP FLOW:= (PKE-TMAX) / (TMIN2-TMAX) * 100 %
        LHLD    PKE
        LDED    TMAX
        ORA     A
        DSBC    D
        SHLD    TTEMP
        LHLD    TMIN2
        LDED    TMAX
        ORA     A
        DSBC    D
        SHLD    TT2EMP
        FILA    TTEMP
        FLOT
        FATB
        FILA    TT2EMP
        FLOT
        FDIV
        FATB
        FFOA    100
        FMUL
;% T TO PEAK EXP FLOW
        FLDB    PKESUM
        FADD
        FSTA    PKESUM
;
;TI = TMAX - TMIN1 / SFREQ
        LHLD    TMAX
        LDED    TMIN1
        ORA     A
        DSBC    D
        SHLD    TTEMP
        FILA    TTEMP
        FLOT
        FATB
        FILA    SFREQ
        FLOT
        FDIV
;AREG = TI
        FLDB    TISUM
        FADD
        FSTA    TISUM

;
        LHLD    PCNUMBERS
        INX     H
        SHLD    PCNUMBERS

ENDLOOP
;
        FLDB    PKISUM
        FILA    PCNUMBERS
        FLOT
```

FILE: QDCAL.ASM

```
        FDIV
        FSTA    PKIAVG
;
        FLDB    PKESUM
        FILA    PCNUMBERS
        FLOT
        FDIV
        FSTA    PKEAVG
;
        FLDB    TISUM
        FILA    PCNUMBERS
        FLOT
        FDIV
        FSTA    TICONTROL
;
;VTTICONTROL = ONEHUND / TI
        FLDB    ONEHUND
        FLDA    TICONTROL
        FDIV
        FSTA    VTTICONTROL
;
;NOTE: THIS COMPUTATION MUST BE DONE AFTER MCA COMPUTATION
;       BECAUSE HYPOPV AND MCAVALUE ARE AT THE SA   ADDR
;       TO CONSERV RAM !!!!
;
;WILL WANT TO PRINT OUT VALUE OF HYPOPNEA (VTLIMIT) = ML
        LDA     QUALFLG
        IF (.A,IS,ZERO)  ;QUANT SO IN ML
          FLDA  VTLIMIT
          FSTA  HYPOPV   ;HYPOP IN ML
        ELSE             ;QUAL SO PRINT IN TERMS OF %
          FLDB  VTMX
          FFOA  10
          FDIV
;AREG = CONTROL VALUE IN ML
          FLDB  VTLIMIT ;HYPOP VOLUME IN ML
          FDIV
          FATB
          FFOA  100
          FMUL
          FSTA  HYPOPV   ;HYPOP IN % OF CONTROL
        ENDIF
;
;
        RET
;


;
STARS: .ASCIS '
****************************************
```

FFOA
FATB

100 ;%

FILE: QDCAL.ASM

```
 '
 ;
 ;
BSBAD: .ASCIS  '
** BAD ISOVOLUME SCALING CALIBRATION:
   TRYED TO SCALE TO @D3 ML

   RETRY WITH Y-SCALING AT LOWER VALUE'
 ;
BSBPT: .WORD   ONEHUND
 ;
 ;
 ;
BADC:  .ASCIS  '
*** BAD QUALITATIVE CALIBRATION: ***
        RC STD   = @D3
        AB STD   = @D3
        # DELTAS = @D1
        MEAN RC  = @D3
        MEAN AB  = @D3
'
;
BADPT:
        .WORD   RCSTD,ABSTD,ACNT,FRC,FAB
;
;
;
;
;
;
BS1:   .ASCIS  '
BASELINE:
QUALITATIVE ISOVOLUME CALIBRATION:
       From @D1 deltas:
                   RC CAL = @D3
                   AB CAL = @D3
       Breathing Freq     = @D3 Bths/min
'
;
;
BS3:   .ASCIS  '
BASELINE WITH QUANTITATIVE ISOVOLUME CALIBRATION:

        Breathing Freq  = @D3 Bths/min
'
;
BS3PT:
        .WORD   FREQCONTRL
;
BS7:   .ASCIS  '
BASELINE WITH GAINS TYPED IN QUANTITATIVELY

        Breathing Freq  = @D3 Bths/min
```

FILE: QDCAL.ASM

```
;
;
BS7PT:
        .WORD   FREQCONTRL
;
;
V1:     .ASCIS  '
QUALITATIVE CALIBRATION:
        From 3D1 deltas:
                        RC CAL = 3D3
                        AB CAL = 3D3
        Breathing Freq     = 3D3 8ths/min
'
;
;
;
V7:     .ASCIS  '
 BASELINE WITH GAINS TYPED IN QUALITATIVELY:
        From 3D1 deltas:
                        RC CAL = 3D3
                        AB CAL = 3D3
        Breathing Freq     = 3D3 8ths/min
'
;
;
;
V2:     .ASCIS  '
        From 3D1 breaths:
        Mean MCA/VT        = 3D3
        Mean %T PK INSP FL = 3D3 %
        Mean %T PK E.F  FL = 3D3 %
        Mean TI            = 3D3 sec'
;

HYP:    .ASCIS  '
        Hypopnea volume    = 3D3 '
AHYP:   .ASCIS  'ml
'

RHYP:   .ASCIS  '% of baseline
'
HYPPT:  .WORD   HYPOPV
;
;
;
;
BS:F
V7PT:
V1PT:   .WORD   XCNT,RCCAL,ABCAL
        .WORD   FREQCONTRL
;
V2PT:   .WORD   XCNT
        .WORD   MCAVT
```

FILE: QDCAL.ASM

```
        .WORD   PKIAVG,PKEAVG
        .WORD   TICONTROL

;
;
;
;
RESCALE:
        FLDB    VTMX
        FFCA    10
        FDIV
        FSTA    ONEHUND ;THIS THE THE VOLUME SCALING TO
;COMPUTE THE FREQ SO CAN COMPUTE THE VMIN FOR CONTROL
        FILA    SECONDS
        FLOT
        FATB
        FFCA    60
        FDIV
        FATB
        FILA    ELPMIN
        FLOT
        FADD    ;AREG = # MINUTES FOR COLLECTION
        FPSH
;
        LHLD    MAXCNT  ;# OF DELTAS
        SRAR    H
        RARR    L       ;MAXCNT/2 == # BREATHS
        SHLD    ITEMP
        FILA    ITEMP
        FLOT
        FATB    ;# BREATHS
        FPOP    ;# MINUTES
        FDIV
        FSTA    FREQCONTRL
;
        FLDB    ONEHUND ;100 % VOLUME
        FLDA    FREQCONTRL      ;FREQ
        FMUL
        FSTA    VMINCONTRL      ;VMIN OF CONTROL
;
;
;
;SMMEAN = MEAN VT IN CUS
        FLDB    SMMEAN
        FLDA    CCS
        FMUL
        FSTA    MEAN    ;MEAN VT IN ML
;
;
        LDA     QUALFLG
        IF (.A,IS,NZERO)        ;QUALITATIVE
;
```

FILE: QDCAL.ASM

```
; SO INIT VTLIMIT TO ONEH ND * VTPCL%
          FLDB  VTPCL
          FFOA  100
          FDIV
          FLDB  ONEHUND
          FMUL
          FSTA  VTLIMIT ;FOR HYPOPNEA DETECTION
;
        ELSE               ;QUANITITATIVE, USE MEAN VT INSTEAD OF ONEHUND
          FLDB  VTPCL
          FFOA  100
          FDIV
          FLDB  MEAN    ;MEAN VT IN ML
          FMUL
          FSTA  VTLIMIT ;FOR HYPOPNEA DETECTION
        ENDIF
;
        FLDB    VTMX
        FFOA    10
        FDIV
        FLDB    MEAN
        FSWP
        FDIV    ;RATIO OF (VTMX/10) / MEAN VT
        FSTA    MEAN
;RCCAL = CURRENT RC GAIN (RCGNF) * MEAN
;ABCAL = CURRENT AB GAIN (ABGNF) * MEAN
        FLDA    MEAN
        FLDB    RCGNF   ;CAL FROM INITIAL CALCS
        FMUL
        FSTA    RCCAL
;
        FLDA    MEAN
        FLDB    ABGNF   ;CAL FROM INITIAL CALCS
        FMUL
        FSTA    ABCAL
;
;NOW THE CAL FACTORS ARE SCALED SO VTMX/10 WILL APPEAR AS 100 % DURING
; LONG TERM
        RET

        .EXTERN QD2
        .LOC    QD2
RCMCA:  .BLKB   2
ABMCA:  .BLKB   2
SMMCA:  .BLKB   2
ADDR1:  .BLKB   2
;
MCAVALUE:
HYPOPV:
        .BLKB   4
;
;
;
```

FILE: QDCAL.ASM

```
VTVALUE:        .BLKB   4
MCAVT: .BLKB   4
VTSUM: .BLKB   4
MCASUM:         .BLKB   4
PKIAVG:         .BLKB   4
PKEAVG:         .BLKB   4
TISUM: .BLKB   4
       .RELOC
;
       .END
```

```
          .IDENT  VSETUP
         .INSERT SP80.ASM
         .INSERT FPMAC.SRC
         .INSERT CALCOM.ASM
         .INSERT CKCOM
         .INSERT SELCOM
         .INSERT BAGCOM
         .INSERT VARCOM.CCC
         .INSERT SYCOM
         .INSERT HRDCOM
;
         .EXTERN APBP,ZALL,AUDEN
;
         .EXTERN RTON,RTOF,RTICK
         .EXTERN TDHE
         .EXTERN DERIV5
         .EXTERN PTRUPD,GETP2,FIND,ROUND
;
         .EXTERN SPON,SPOF
;

;
         .ENTRY   SETUP
;
;
CR       =        0DH
         FINIT
;
;
SETUP:
;
;SETUP THE CLOCK FOR VALIDATION
;
;SAMPLE AT 20 PTS PER SEC
         PUSH     H
; INIT REAL-TIME BUFFER POINTERS
; MODIFIED  09-24-81
         MVI      A,3
         STA      WAITFLG
;
         XRA      A
         STA      WRAPF
         STA      SECFLG
         CMA
         STA      BFLG
         XRA      A
         STA      VFRSTMX
         LXI      H,0
         SHLD     ELPTM
         SHLD     ELPMIN
         SHLD     SECONDS
         SHLD     CPPTR
;
```

FILE: VSETUP.ASM

```
        LXI     H,0
        SHLD    RIPT
        SHLD    ODRIPT
        SHLD    SPTEMP
        SHLD    PNSUM
;
;
        LXI     H,8     ;SKIP THE 1ST 4  DATA POINTS
        SHLD    ROPT
;
        LXI     H,TMBUFF
        MVI     M,0
        INX     H
        MVI     M,0
          LXI   H,0
          SHLD  TIME
; INIT VARIABLES FOR PICKING MAX AND MINS
        XRA     A
        STA     PTF     ;START BY LOOKING FOR MAX PT
        STA     SLOPEF  ;INIT MAX NOT FOUND
;
        XRA     A
        STA     INTFLG
        CMA
        STA     GFLG    ;INDICATES CLOCK ON
        CALL    AUDEN
        CALL    APBP
        CALL    ZALL
;
;
          LXI   H,IRSRV
          MVI   A,20    ;CLOCK RATE
          CALL  RTON    ;TURN ON CLOCK
;
        LDA     BAG
        IF (.A,IS,ZERO) ;USING SPIROMETER
          CALL  SPON
        ENDIF
;
;
        POP     H
        RET
;
;
;
CLKSTP:
        ;STOP DATA COLLECTION
        ;TURN CLOCK OFF
;
;MODIFIED 09-24-81
;
        CALL    RTOF    ;TURN OFF CLOCK
        LDA     BAG
```

FILE: VSETUP.ASM

```
        IF (.A,IS,ZERO) ;USING SPIROMETER
          CALL  SPOF
        ENDIF
        XRA     A
        STA     GFLG
        CALL    AUDEN
        CALL    APBP
;
;********************
        POP     PSW
        POP     H
        POP     D
        POP     B
;
        RET
;
;
;
IRSRV:
;
; INTERRUPT SERVICE ROUTINE
;
        PUSH    B
        PUSH    D
        PUSH    H
        PUSH    PSW
;
;
        CALL    RTICK   ;SERVICE INTERRUPT
        LDA     INTFLG
        IF (.A,IS,NZERO)        ;THEN INTERRUPT INTERRUPT
          NOP
        ELSE
          CMA
          STA   INTFLG  ;SET FLAG
        ENDIF
;
        CALL    CLKTIK
;
;
;
;
        CALL    SAMPLE
;
;
;
;
        LDA     SLOPEF
        IF (.A,IS,ZERO)
          CALL  GETP2   ;RETURNS C IF < 5 PTS IN BUFFER
                                ;THIS JUST MAKES SURE EXTRA
                                ;POINTS IN BUFFER
          JC    EXIT    ;NOT ENOUGH POINTS IN BUFFER
```

FILE: VSETUP.ASM

```
          MVI   A,0FFH
          STA   SLOPEF
        ENDIF
;
        CALL    DERIV5
;
        LDA     VFRSTMX
        IF (.A,IS,ZERO) ;HAVE NOT FOUND 1ST MAX
          LHLD  ROPT
          CALL  FIND
          IF (PSW,IS,NCARRY)     ;NOT MAX
                LHLD    ROPT
                LXI     B,RSIZE
                CALL    PTRUPD
                SHLD    ROPT
                JMP     EXIT
          ENDIF
                ;MAX FOUND
          LDA   VFRSTMX
          CMA
          STA   VFRSTMX
          LDA   PTF
          CMA
          STA   PTF
          SHLD  SPTEMP   ;TEMP CRIT PT
          SDED  RCTEMP   ;CORRESPONDING RC PT
          SBCD  ABTEMP   ;CORRESPONDING AB PT
;
          LHLD  ROPT
          LXI   B,RSIZE
          CALL  PTRUPD
          SHLD  ROPT
          JMP   EXIT
        ENDIF
;
;
                ;INIT MAX FOUND
          LHLD  ROPT
          CALL  FIND
;
;UPDATE ROPT FOR NEXT TIME
;
        PUSH    PSW
        PUSH    D
        PUSH    B
        PUSH    H
;
          LHLD  ROPT
          LXI   B,RSIZE
          CALL  PTRUPD
          SHLD  ROPT
          POP   H
          POP   B
```

FILE: VSETUP.ASM

```
          POP    D
          POP    PSW
;
;
;FIND RETURNED C SET IF CP FOUND
;AND HL HOLDS SP PT VALUE
; AND DE HOLDS RC PT VALUE
; AND BC HOLDS AB PT VALUE
;
        IF (PSW,IS,CARRY)
        SHLD    SPVALUE
        SDED    RCVALUE
        SBCD    ABVALUE
;
;
        LDA     PTF
        IF (.A,IS,ZERO) ;THEN MAX FOUND
                XRA     A
                CMA
                STA     BFLG
                LXI     D,SPMAX
                LHLD    CPPTR
                DAD     D
;
                LDA     BAG
                IF (.A,IS,ZERO) ;THEN USING SPIROMETER, AND
                                ;SPVALUE HOLDS SPIROMETER VALUE
                LDED    SPVALUE
                ELSE            ;USING SPIROBAG,SO FIXCU HOLDS VALUE
                LDED    FIXCU
                ENDIF
;
                MOV     M,E
                INX     H
                MOV     M,D
;
                LHLD    CPPTR
                LXI     D,RCMAX
                DAD     D
                LDED    RCVALUE
                MOV     M,E
                INX     H
                MOV     M,D
;
                LHLD    CPPTR
                LXI     D,ABMAX
                DAD     D
;
;
;IF VALIDATING AND IF USING SPIROBAG
; THEN SPVALUE HOLDS THE SUM MAX
                LDA     BAG
                IF (.A,IS,NZERO)        ;THEN USING SPIROBAG
```

FILE: VSETUP.ASM

```
                LDED    SPVALUE         ;SUM VALUE
                JMP     L1001
                ENDIF
;
                LDED    ABVALUE
L1001:
                MOV     M,E
                INX     H
                MOV     M,D
                LHLD    MAXCNT
                INX     H
                SHLD    MAXCNT
                LHLD    CPPTR
                INX     H
                INX     H
                SHLD    CPPTR
                LHLD    MAXCNT
                LXI     D,BRTHMX
                ORA     A
                DSBC    D
                IF (PSW,IS,ZERO)        ;THEN BUFFER FULL
                  JMP   CLKSTP
                ENDIF
          ELSE
                LHLD    CPPTR
                LXI     D,SPMIN
                DAD     D
;
                LDA     BAG
                IF (.A,IS,ZERO) ;THEN USING SPIROMETER, AND
                                ;SPVALUE HOLDS SPIROMETER VALUE
                LDED    SPVALUE
                ELSE            ;USING SPIROBAG,SO MIN = 0
                LXI     D,0
                ENDIF
;
                MOV     M,E
                INX     H
                MOV     M,D
;
                LHLD    CPPTR
                LXI     D,RCMIN
                DAD     D
                LDED    RCVALUE
                MOV     M,E
                INX     H

                MOV     M,D
;
                LHLD    CPPTR
                LXI     D,ABMIN
                DAD     D
;
```

FILE: VSETUP.ASM

```
        LHLD  DATA
        MOV   A,H
        CMA
        ANI   0FH
        MOV   H,A
        MOV   A,L
        CMA
        MOV   L,A
        SHLD  DATA
;
       ENDIF
       RET
;
;
;
;
;
;
PRNG:
;
;HL HOLDS THE RING INPUT PTR
;DE HOLDS ADDR OF RING
;
       DAD    D
       LDED   DATA
       MOV    M,E
       INX    H
       MOV    M,D
       RET
;
       .END
```

FILE: QDCSTATS.ASM

```
            .IDENT  QDSTATS
           .INSERT FPMAC.SRC
           .INSERT SP80
           FINIT
           .INSERT VTCCOM
           .INSERT CALCOM
           .INSERT OLQCOM
           .INSERT CKCOM
           .INSERT VARCOM.CCC
           .INSERT SYCOM
           .INSERT QD1.ASM
;
;
           .EXTERN TDHE,ROUND
;
;
           .ENTRY   PRTQDC
           .ENTRY   CMPSTATS
;
PRTQDC:
           ;THIS IS THE ENTRY POINT FROM LONG TERM
           CALL     CMPSTATS
           RC
           FLDB     RCSTD
           FLDA     ABSTD
           FDIV
           FSTA     ABCAL
           FPRN     QDCV,QDCPT
           RET
;
QDCV:   .ASCIS   '
QDC = 3D3:       # DELTAS = 3D1
        MEAN     STD      COV
RC:     3D3      3D3      3D3
AB:     3D3      3D3      3D3 '
;
QDCPT: .WORD    ABCAL,XCNT
       .WORD    FRC,RCSTD,COVRC
       .WORD    FAB,ABSTD,COVAB
;
;
NODELTS:        .ASCIS  '
NO QDC DELTAS AVAILABLE
'
;
;
;
;
CMPSTATS:
;RCDATA AND ABDATA HOLD THE DELTAS FOR RC AND AB
;
;COMPUTE THE MEAN AND STD OF RC, AB AND RC+AB
;
```

FILE: QDCSTATS.ASM

```
        LHLD    DLTIPTR
        SHLD    DLTOFF  ;SAVE IT INCASE IT CHANGES IN THE
                        ;MIDDLE OF THIS DURING LONG TERM
;
;
        LDA     DLTFULL
        IF (.A,IS,ZERO) ;RING NOT FULL YET
          LXI   H,0
          SHLD  OFFSET
          LDED  DLTOFF
          CALL  TDHE
          IF (PSW,IS,ZERO)      ;THEN NO DELTAS
                LXI     H,NODELTS
                CALL    TXTYP
                STC
                RET
          ENDIF
        ELSE                    ;RING IS FULL
          LHLD  DLTOFF  ;POINTS TO NEXT PLACE TO PUT, SO WILL BE
                        ;THE OLDEST VALUE
          SHLD  OFFSET
        ENDIF
;
;
;
;1ST TIME THRU THE DATA COMPUTE MEAN AND STD OF JUST SUM
;
;2ND TIME THUR THE DATA ONLY USE DATA WHERE SUM IS WITHIN +-QDCSTD OF MEAN
; OF SUM
;
        FFOA    0
        FSTA    SMSUM
        FSTA    SMXXSUM
        FSTA    XCNT

;
LOOP
        LHLD    OFFSET
        LXI     D,RCDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    IRCV
;
        LHLD    OFFSET
        LXI     D,ABDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    IABV
;
```

FILE: QDCSTATS.ASM

```
        CALL    SUMMERS
;
        LHLD    OFFSET
        INX     H
        INX     H
        SHLD    OFFSET
        LXI     D,1000
        CALL    TDHE
        IF (PSW,IS,ZERO)
          LXI   H,0
          SHLD  OFFSET
        ENDIF
;

;
;QUIT WHEN OFFSET = DLTOFF
        LHLD    OFFSET
        LDED    DLTOFF
        CALL    TDHE
        IF (PSW,IS,ZERO)
          RET   ;EXIT LOOP
        ENDIF
ENDLOOP
;COMPUTE MEAN AND STD OF SUM
        FLDB    SMSUM
        FLDA    XCNT
        FDIV
        FSTA    SMMEAN
;
        FLDB    SMSUM
        FLDA    SMSUM
        FMUL
        FATB
        FLDA    XCNT
        FDIV
        FLDB    SMXXSUM
        FSUB
        FATB
        FLDA    XCNT
        FDIV
        FSQR
        FSTA    SMSTD
;HIGH LIMIT = SMMEAN + QDCSTD*SMSTD
; LOW LIMIT = SMMEAN - QDCSTD*SMSTD
;
        FLDB    QDCSTD
        FLDA    SMSTD
        FMUL
        FLDB    SMMEAN
        FADD
        FSTA    SMHIGH
;
        FLDB    QDCSTD
```

FILE: QDCSTATS.ASM

```
        FLDA    SMSTD
        FMUL
        FLDB    SMMEAN
        FSUB
        FSTA    SMLOW
;
;NOW COMPUTE MEAN AND STD OF RC AND AB FOR ALL PAIRS WHERE
;  RC+AB < SMHIGH AND RC+AB > SMLOW
;
;
        LDA     DLTFULL
        IF (.A,IS,ZERO) ;RING NOT FULL YET
          LXI   H,0
          SHLD  OFFSET
        ELSE            ;RING IS FULL
          LHLD  DLTOFF  ;POINTS TO NEXT PLACE TO PUT, SO WILL BE
                        ;THE OLDEST VALUE
          SHLD  OFFSET
        ENDIF
;
;
        FFOA    0
        FSTA    RCSUM
        FSTA    RCXXSUM
        FSTA    ABSUM
        FSTA    ABXXSUM
        FSTA    XCNT

;
LOOP
        LHLD    OFFSET
        LXI     D,RCDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    IRCV
;
        LHLD    OFFSET
        LXI     D,ABDATA
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    IABV
;
        CALL    RASUMMERS
;
        LHLD    OFFSET
        INX     H
        INX     H
        SHLD    OFFSET
        LXI     D,1000
```

FILE: QDCSTATS.ASM

```
        CALL    TDHE
        IF (PSW,IS,ZERO)
          LXI   H,0
          SHLD  OFFSET
        ENDIF
;
;
;QUIT WHEN OFFSET = DLTOFF
        LHLD    OFFSET
        LDED    DLTOFF
        CALL    TDHE
        IF (PSW,IS,ZERO)
          RET   ;EXIT LOOP
        ENDIF
ENDLOOP
;
;IF XCNT < 2, THEN NO GOOD DATA
        FLDB    XCNT
        FFOA    2
        FSUB
        FTST    AREG,LT
        IF (PSW,IS,ZERO)
          LXI   H,NODELTS
          CALL  TXTYP
          STC
          RET
        ENDIF
;COMPUTE MEAN OF RC AND AB
        FLDB    RCSUM
        FLDA    XCNT
        FDIV
        FSTA    FRC
;
        FLDB    ABSUM
        FLDA    XCNT
        FDIV
        FSTA    FAB
;
;COMPUTE STD OF RC AND STD OF AB
;
        FLDB    RCSUM
        FLDA    RCSUM
        FMUL
        FATB
        FLDA    XCNT
        FDIV
        FLDB    RCXXSUM
        FSUB
        FATB
        FLDA    XCNT
        FDIV
        FSQR
```

FILE: QDCSTATS.ASM

```
        FSTA    RCSTD
;
        FLDB    ABSUM
        FLDA    ABSUM
        FMUL
        FATB
        FLDA    XCNT
        FDIV
        FLDB    ABXXSUM
        FSUB
        FATB
        FLDA    XCNT
        FDIV
        FSQR
        FSTA    ABSTD
;MAKE VALUES ML
        FLDB    FRC
        FLDA    CCS
        FMUL
        FSTA    FRC
;
        FLDB    FAB
        FLDA    CCS
        FMUL
        FSTA    FAB
;

        FLDB    ABSTD
        FLDA    CCS
        FMUL
        FSTA    ABSTD
;
        FLDB    RCSTD
        FLDA    CCS
        FMUL
        FSTA    RCSTD
;

;COV = STD/MEAN
        FLDB    RCSTD
        FLDA    FRC
        FDIV
        FATB
        FFOA    100
        FMUL
        FSTA    COVRC
;
        FLDB    ABSTD
        FLDA    FAB
        FDIV
        FATB
        FFOA    100
        FMUL
```

FILE: QDCSTATS.ASM

```
        FSTA    COVAB
        ORA     A
        RET
;
;
;
RASUMMERS:
        FILA    IRCV
        FLOT
        FSTA    FRC

        FILA    IABV
        FLOT
        FSTA    FAB
;
;DO NOT USE IF FRC+FAB > SMHIGH OR IF FRC+FAB < SMLOW
        FLDB    FRC
        FLDA    FAB
        FADD
        FATB
        FLDA    SMHIGH
        FSUB
        FTST    AREG,GT
        IF (PSW,IS,ZERO)
          RET
        ENDIF
;
        FLDB    FRC
        FLDA    FAB
        FADD
        FATB
        FLDA    SMLOW
        FSUB
        FTST    AREG,LT
        IF (PSW,IS,ZERO)
          RET
        ENDIF
;
;
;
        FLDA    FRC
        FLDB    RCSUM
        FADD
        FSTA    RCSUM
;
        FLDB    FRC
        FLDA    FRC
        FMUL
        FLDB    RCXXSUM
        FADD
        FSTA    RCXXSUM
;
        FLDA    FAB
```

FILE: QDCSTATS.ASM

```
        FLDB    ABSUM
        FADD
        FSTA    ABSUM
;
        FLDB    FAB
        FLDA    FAB
        FMUL
        FLDB    ABXXSUM
        FADD
        FSTA    ABXXSUM

;
;
;
        FLDB    XCNT
        FFOA    1
        FADD
        FSTA    XCNT
;
        RET
;
;
;
;
;
SUMMERS:
        FILA    IRCV
        FLOT
        FATB
        FILA    IABV
        FLOT
        FADD
        FSTA    FSUM

        FLDA    FSUM
        FLDB    SMSUM
        FADD
        FSTA    SMSUM
;
        FLDA    FSUM
        FLDB    FSUM
        FMUL
        FLDB    SMXXSUM
        FADD
        FSTA    SMXXSUM
;
;
        FLDB    XCNT
        FFOA    1
        FADD
        FSTA    XCNT
        RET
;
```

FILE: QDCSTATS.ASM

```
;
;
;
;
            .END
```

FILE: CFIND.ASM

```
;
        .IDENT   CFIND
        .INSERT SP80.ASM
        .INSERT CALCOM
        .INSERT SELCOM
        .INSERT EFFCOM
        .INSERT DRVCOM
        .INSERT SIOCOM
        .INSERT FPMAC.SRC
        .INSERT PKCOM.ASM
        .ENTRY   FIND,GETP2,DERIV5
        .EXTERN TDHE,PTRUPD
        FINIT
FIND:
;
;HL = OFFSET OF CURRENT PT ON ENTRANCE
;
; ON EXIT: IF CP FOUND, THEN CARRY SET AND
;          HL = SPIROMETER PT
;          DE = RIB CAGE PT
;          BC = ABDOMEN PT
        SHLD    CUROFF
;
        LHLD    CUROFF
        LXI     D,SPBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURSP
;
        LHLD    CUROFF
        LXI     D,RCBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURRC
;
        LHLD    CUROFF
        LXI     D,ABBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURAB
;
        LHLD    CUROFF
        LXI     D,TMBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
```

FILE: CFIND.ASM

```
        SDED    CURTM
;
;
        CALL    GTSIGN  ;CHECK SIGNS OF DERIVATIVES
;
;
        LDA     PTF
        IF (.A.IS.NZERO)        ;LOOK FOR MIN
          LHLD  SPTEMP
          LDED  CURSP
          ORA   A
          DSBC  D
          IF (PSW.IS.NCARRY)  ;NEW TMP MIN FOUND
             LHLD       CURSP
             SHLD       SPTEMP
             LHLD       CURRC
             SHLD       RCTEMP
             LHLD       CURAB
             SHLD       ABTEMP
             LHLD       CUROFF
             SHLD       OFFTEMP
             LHLD       CURTM
             SHLD       TMTEMP

;1. ADD CURRENT RCDERV PT TO RC COUNTS
;2. ADD RCTCNT TO RC COUNTS
;3. RCTCNT <== 0
;4. ADD CURRENT ABDERV TO AB COUNTS
;5. ADD ABTCNT TO AB COUNTS
;6. ABTCNT <== 0
                CALL    UPDT1

             ORA        A
             RET
          ELSE          ;POSSIBLE CP SO CHECK SLOPE BETWEEN
                        ;CURRNT PT AND TEMP PT
             LHLD       CURSP
             LDED       SPTEMP
             ORA        A
             DSBC       D
             ;NOW HL HOLDS DIFFERENCE
             LDED       MINCC
             ORA        A
             DSBC       D
             IF (PSW.IS.NCARRY)  ;THEN SPTEMP IS CP
                LHLD    OFFTEMP
                SHLD    CPOFF
                LHLD    SPTEMP
                PUSH    H
                LHLD    RCTEMP
                PUSH    H
                LHLD    ABTEMP
                PUSH    H
```

FILE: CFIND.ASM

```
                LHLD    CURSP
                SHLD    SPTEMP
                LHLD    CURRC
                SHLD    RCTEMP
                LHLD    CURAB
                SHLD    ABTEMP
                LHLD    CUROFF
                SHLD    OFFTEMP
                LHLD    TMTEMP
                SHLD    CPTIME  ;TIME OF THIS CP
;
                LHLD    CURTM
                SHLD    TMTEMP  ;NEW TEMP
;
;1. STORE RC COUNTS
;2. RC COUNTS <== RCTCNT
;3. RCTCNT <== 0
;4. STORE AB COUNTS
;5. AB COUNTS <== ABTCNT
;6. ABTCNT <== 0
;
                CALL    UPDT2
;
                POP     B       ;AB VALUE
                POP     D       ;RC VALUE
                POP     H       ;SP VALUE
                STC     ;SET CARRY
                RET
            ELSE
        ;NOT A LARGE ENOUGH SLOPE
;
;1. ADD RCDERV TO RCTCNT
;2. ADD ABDERV TO ABTCNT
                CALL    UPDT3
                ORA     A
                RET
           ENDIF
          ENDIF
       ELSE             ;LOOK FOR MAX
         LHLD  SPTEMP
          LDED CURSP
         XCHG
         ORA   A
         DSBC  D
         IF (PSW,IS,NCARRY)     ;;THEN CURRENT >= SPTEMP
           LHLD         CURSP
           SHLD         SPTEMP
           LHLD         CURRC
           SHLD         RCTEMP
           LHLD         CURAB
           SHLD         ABTEMP
           LHLD         CUROFF
           SHLD         OFFTEMP
```

FILE: CFIND.ASM

```
            LHLD        CURTM
            SHLD        TMTEMP
;
                CALL    UPDT1
            ORA A
            RET
          ELSE  ;POSSIBLE CP
            LHLD        SPTEMP
            LDED        CURSP
            ORA A
            DSBC        D
        ;NOW HL = DIFF
            LDED        MINCI
            ORA A
            DSBC        D
            IF (PSW,IS,NCARRY)  ;THEN SPTEMP IS CP
                LHLD    OFFTEMP
                SHLD    CPOFF
                LHLD    SPTEMP
                PUSH    H
                LHLD    RCTEMP
                PUSH    H
                LHLD    ABTEMP
                PUSH    H
;
                LHLD    TMTEMP
                SHLD    CPTIME  ;TIME OF CP
;
                LHLD    CURSP
                SHLD    SPTEMP
                LHLD    CURRC
                SHLD    RCTEMP
                LHLD    CURAB
                SHLD    ABTEMP
                LHLD    CUROFF
                SHLD    OFFTEMP
                LHLD    CURTM
                SHLD    TMTEMP
;
                CALL    UPDT2
                POP     B       ;AB VALUE
                POP     D       ;RC VALUE
                POP     H       ;SP VALUE
                STC
                RET
            ELSE        ;NOT LARGE ENOUGH SLOPE
                CALL    UPDT3
                ORA     A
                RET
            ENDIF
          ENDIF
        ENDIF
;
```

FILE: CFIND.ASM

```
;
;
;
;
;GETP2:
;
;SEE IF AT LEAST 5 POINTS IN RING BUFFER
;
;       LHLD    RIPT
;       LXI     D,10
;       ORA     A
;       DSBC    D
;       IF (PSW,IS,CARRY)   ;THEN < 5 PTS
;         STC
;       ELSE
;         ORA   A
;       ENDIF
;       RET
;
;
UPOT1:

;1. ADD CURRENT ABS(RCDERV) PT TO RC COUNTS
;2. ADD RCTCNT TO RC COUNTS
;3. RCTCNT <== 0
;4. ADD CURRENT ABS(ABDERV) TO AB COUNTS
;5. ADD ABTCNT TO AB COUNTS
;6. ABTCNT <== 0
;
;
;
;******
;NOTE : DO NOT SEPEATAE INPHASE AND OUT "OF PHASE FOR A.
;*****
                LHLD    ABSRCD
                LDED    RCIN
                DAD     D
                SHLD    RCIN
;
;
                LHLD    RCIN
                LDED    RCTICNT
                DAD     D
                SHLD    RCIN
;
;
                LXI     H,0
                SHLD    RCTICNT
;
;
                LHLD    ABSABD
                LDED    ABIN
                DAD     D
```

FILE: CFIND.ASM

```
                SHLD    ABIN
;
;
                LHLD    ABIN
                LDED    ABTICNT
                DAD     D
                SHLD    ABIN
;
                LXI     H,0
                SHLD    ABTICNT
;
;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE VALUES
;     ADD THEM ALL
;
                LHLD    ABSSMD
                LDED    SMIO
                DAD     D
                SHLD    SMIO
;
;
                LHLD    SMIO
                LDED    SMTCNT
                DAD     D
                SHLD    SMTCNT
;
;
                LXI     H,0
                SHLD    SMTCNT
;
;FOR PEAK FLOW STUFF:
;SMDERV = CURRENT FLOW, ABSSMD = ABS(SMDERV)
;
;IF ON INSP SIDE:, LOOKING FOR MAX (PTF=0)
        LDA     PTF
        IF (.A,IS,ZERO) ;ON INSP SIDE
;IF CURRENT FLOW > 0, OR IF ABSSMD = SMDERV
            LHLD        ABSSMD
            LDED        SMDERV
            CALL        TOHE
            IF (PSW,IS,ZERO)    ;THEN CURRENT FLOW > 0
;IF CURRENT FLOW > TEMPK
                LHLD    TEMPK
                LDED    SMDERV
                ORA     A
                DSBC    D
                IF (PSW,IS,CARRY)       ;CURRENT FLOW > TEMPK
                        LHLD    SMDERV
                        SHLD    TEMPK
                        LHLD    CURTM
                        SHLD    PKTIME
                ENDIF
            ENDIF
;IF TTPOS > TEMPK
```

FILE: CFIND.ASM

```
            LHLD        TEMPK
            LDED        TTPOS
            ORA A
            DSBC        D
            IF (PSW,IS,CARRY)    ;TTPOS > TEMPK
                LHLD    TTPOS
                SHLD    TEMPK
                LHLD    TTPTM
                SHLD    PKTIME
            ENDIF
;
            LXI H,0
            SHLD        TTPOS
            SHLD        TTNEG
            LHLD        CURTM
            SHLD        TTPTM
            SHLD        TTNTM
;
        ELSE                ;ON THE EXP SIDE (LOOKING FOR MIN
;
;IF CURRENT FLOW < 0, OR IF ABSSMD NOT= SMDERV
            LHLD        ABSSMD
            LDED        SMDERV
            CALL        TDHE
            IF (PSW,IS,NZERO)    ;THEN CURRENT FLOW   0
;IF ABS(CURRENT FLOW) > TEMPK
                LHLD    TEMPK
                LDED    ABSSMD
                ORA     A
                DSBC    D
                IF (PSW,IS,CARRY)       ;ABS(CURRENT FLOW) > TEMPK
                        LHLD    ABSSMD
                        SHLD    TEMPK
                        LHLD    CURTM
                        SHLD    PKTIME
                ENDIF
             ENDIF
;IF TTNEG > TEMPK
            LHLD        TEMPK
            LDED        TTNEG
            ORA A
            DSBC        D
            IF (PSW,IS,CARRY)    ;TTNEG > TEMPK
                LHLD    TTNEG
                SHLD    TEMPK
                LHLD    TTNTM
                SHLD    PKTIME
            ENDIF
;
            LXI H,0
            SHLD        TTPOS
            SHLD        TTNEG
            LHLD        CURTM
```

FILE: CFIND.ASM

```
                SHLD        TTPTM
                SHLD        TTNTM
        ;
        ;
            ENDIF

                    RET
        ;
        ;
        UPDT2:
        ;
        ;1. STORE RC COUNTS
        ;2. RC COUNTS <== RCTCNT
        ;3. RCTCNT <== 0
        ;4. STORE AB COUNTS
        ;5. AB COUNTS <== ABTCNT
        ;6. ABTCNT <== 0
                LHLD  RCIN
                SHLD  RCINVOL
        ;
        ;
                LHLD  RCTICNT
                SHLD  RCIN
        ;
        ;
                LXI   H,0
                SHLD  RCTICNT
        ;
                LHLD  ABIN
                SHLD  ABINVOL
        ;
        ;
                LHLD  ABTICNT
                SHLD  ABIN
        ;
        ;
                LXI   H,0
                SHLD  ABTICNT
        ;
        ;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE
                LHLD  SMIO
                SHLD  SMVOL
        ;
        ;
                LHLD  SMTCNT
                SHLD  SMIO
        ;
        ;
                LXI   H,0
                SHLD  SMTCNT
        ;
        ;FOR PEAK FLOW STUFF:
        ;SMDERV = CURRENT F__        ..SMD = ABS(SMDERV)
```

FILE: CFIND.ASM

```
;
;IF ON INSP SIDE:, LOOKING FOR MAX (PTF=0)
       LDA     PTF
       IF (.A.IS.ZERO) ;ON INSP SIDE
;TEMPK IS THE PEAK FLOW, AND PKTIME IS THE TIME OF IT
;STORE THE TIME OF THE PEAK FLOW
          CALL PKSTORE
          LHLD TTNEG   ;NOW WILL BE ON EXP SIDE
          SHLD TEMPK
          LHLD TTNTM
          SHLD PKTIME
          LXI  H,0
          SHLD TTPOS
          SHLD TTNEG
          LHLD CURTM
          SHLD TTPTM
          SHLD TTNTM
       ELSE            ;ON EXP SIDE
;TEMPK IS THE PEAK FLOW, AND PKTIME IS THE TIME OF IT
;STORE THE TIME OF THE PEAK FLOW
          CALL PKSTORE
          LHLD TTPOS   ;NOW WILL BE ON INSP SIDE
          SHLD TEMPK
          LHLD TTPTM
          SHLD PKTIME
          LXI  H,0
          SHLD TTPOS
          SHLD TTNEG
          LHLD CURTM
          SHLD TTPTM
          SHLD TTNTM
       ENDIF
;
       RET
;
;
;
;
UPDT3:
;
;1. ADD ABS(RCDERV) TO RCTCNT
;2. ADD ABS(ABDERV) TO ABTCNT
;
        LHLD  ABSRCD
        LDED  RCTICNT
        DAD   D
        SHLD  RCTICNT
;
        LHLD  ABSABD
        LDED  ABTICNT
        DAD   D
        SHLD  ABTICNT
```

FILE: CFIND.ASM

```
;
;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE
;
        LHLD  ABSSMD
        LDED  SMTCNT
        DAD   D
        SHLD  SMTCNT
;
;
;FOR PEAK FLOW STUFF:
;SMDERV = CURRENT FLOW, ABSSMD = ABS(SMDERV)
;
;IF CURRENT FLOW > 0
      LHLD    SMDERV
      LDED    ABSSMD
      CALL    TDHE
      IF (PSW,IS,ZERO)        ;THEN CURRENT FLOW > 0
;IF CURRENT FLOW > TTPOS
         LHLD TTPOS
         LDED SMDERV
         ORA  A
         DSBC D
         IF (PSW,IS,CARRY)
              LHLD    SMDERV
              SHLD    TTPOS
              LHLD    CURTM
              SHLD    TTPTM
         ENDIF
      ELSE
;IF ABS(CURRENT FLOW) > TTNEG
         LHLD TTNEG
         LDED ABSSMD
         ORA  A
         DSBC D
         IF (PSW,IS,CARRY)
              LHLD    ABSSMD
              SHLD    TTNEG
              LHLD    CURTM
              SHLD    TTNTM
         ENDIF
      ENDIF
;
      RET
;
;
;
PKSTORE:
      LHLD    PKTIME
      SHLD    PKVALUE
      RET

;
;
```

FILE: CFIND.ASM

```
;
GTSIGN:
        LHLD    RCDERV  ;CURRENT RC DERIV VALUE
        MOV     A,H
        ANI     80H
        STA     RCSIGN
;
        LHLD    ABDERV  ;CURRENT AB DERIV VALUE
        MOV     A,H
        ANI     80H
        STA     ABSIGN
;
        LHLD    SMDERV
        MOV     A,H
        ANI     80H
        STA     SMSIGN
;
;
        MOV     B,A
        LDA     RCSIGN
        IF (.A,EQ,.B)   ;THEN RC INPHASE W/ SUM
          XRA   A
          CMA
          STA   RCINPHS
        ELSE
          XRA   A
          STA   RCINPHS
        ENDIF
;
        LDA     SMSIGN
        MOV     B,A
        LDA     ABSIGN
        IF (.A,EQ,.B)   ;THEN AB INPHASE W/ SUM
          XRA   A
          CMA
          STA   ABINPHS
        ELSE
          XRA   A
          STA   ABINPHS
        ENDIF
        RET
;
;
;
;
;
;
;
;
;
DERIV5:
;***********************
;DERIV USING 9 POINTS
```

FILE: CFIND.ASM

```
;**********************
;
;DERIVATIVE USING 5 POINTS
;
;SRCOFST HOLDS OFFSET TO GET Y5 FROM RAW DATA BUFFERS
;
;ASSUME: RCY1,RCY2,RCY3,RCY4, ABY1,ABY2,ABY3,ABY4 ALREADY SET
;
        LXI     D,RCBUFF
        LHLD    SRCOFST
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY9
;
        LHLD    SRCOFST
        LXI     D,ABBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY9
;
        LXI     B,RSIZE ;UPDATE FOR NEXT TIME
        LHLD    SRCOFST
        CALL    PTRUPD
        SHLD    SRCOFST
;DERIV = (9-1)*4  + (8-2)*3  + (7-3)*2  + (6-4)
;
        LHLD    RCY9
        LDED    RCY1
        ORA     A
        DSBC    D
        DAD     H       ;(RCY9-RCY1)*2
        DAD     H       ;(RCY9-RCY1)*4
        PUSH    H
;
        LHLD    RCY8
        LDED    RCY2
        ORA     A
        DSBC    D
        MOV     E,L
        MOV     D,H
        DAD     H       ;*2
        DAD     D       ;*3
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    RCY7
        LDED    RCY3
        ORA     A
```

FILE: CFIND.ASM

```
        DSBC    D
        DAD     H
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    RCY6
        LDED    RCY4
        ORA     A
        DSBC    D
        POP     D
        DAD     D
        SHLD    RCDERV
;
;*****: DIVIDE RCDERV BY 4 TO AVOID OVERFLOW WHEN INTEGRATING IT
        LHLD    RCDERV
        SRAR    H
        RARR    L
        SRAR    H
        RARR    L
        SHLD    RCDERV

;***
;DERIV = (9-1)*4  + (8-2)*3  + (7-3)*2  + (6-4)
;
        LHLD    ABY9
        LDED    ABY1
        ORA     A
        DSBC    D
        DAD     H       ;(ABY9-ABY1)*2
        DAD     H       ;(ABY9-ABY1)*4
        PUSH    H
;
        LHLD    ABY8
        LDED    ABY2
        ORA     A
        DSBC    D
        MOV     E,L
        MOV     D,H
        DAD     H       ;*2
        DAD     D       ;*3
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    ABY7
        LDED    ABY3
        ORA     A
        DSBC    D
        DAD     H
        POP     D
        DAD     D
        PUSH    H
```

FILE: CFIND.ASM

```
;
        LHLD    ABY6
        LDED    ABY4
        ORA     A
        DSBC    D
        POP     D
        DAD     D
        SHLD    ABDERV
;
;*****: DIVIDE ABDERV BY 4 TO AVOID OVERFLOW WHEN INTEGRATING IT
        LHLD    ABDERV
        SRAR    H
        RARR    L
        SRAR    H
        RARR    L
        SHLD    ABDERV

;***
;
;RESET VALUES FOR NEXT TIME
        LHLD    RCY2
        SHLD    RCY1
        LHLD    RCY3
        SHLD    RCY2
        LHLD    RCY4
        SHLD    RCY3
        LHLD    RCY5
        SHLD    RCY4
        LHLD    RCY6
        SHLD    RCY5
        LHLD    RCY7
        SHLD    RCY6
        LHLD    RCY8
        SHLD    RCY7
        LHLD    RCY9
        SHLD    RCY8
;
        LHLD    ABY2
        SHLD    ABY1
        LHLD    ABY3
        SHLD    ABY2
        LHLD    ABY4
        SHLD    ABY3
        LHLD    ABY5
        SHLD    ABY4
        LHLD    ABY6
        SHLD    ABY5
        LHLD    ABY7
        SHLD    ABY6
        LHLD    ABY8
        SHLD    ABY7
        LHLD    ABY9
        SHLD    ABY8
```

FILE: CFIND.ASM

```
;
;
        LHLD    RCDERV
        LDED    ABDERV
        DAD     D
        SHLD    SMDERV
;
;
;COMPUTE ABSOLUTE VALUE OF RCDERV AND ABDERV, AND SMDERV
        LHLD    RCDERV
        MOV     A,H
        ANI     80H
        IF (.A,IS,NZERO)          ;THEN RCDERV < 0
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSRCD
        ELSE
          SHLD  ABSRCD
        ENDIF
;
        LHLD    ABDERV
        MOV     A,H
        ANI     80H
        IF (.A,IS,NZERO)          ;THEN ABDERV < 0
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSABD
        ELSE
          SHLD  ABSABD
        ENDIF
;
        LHLD    SMDERV
        MOV     A,H
        ANI     80H
        IF (.A,IS,NZERO)          ;THEN SMDERV < 0
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSSMD
```

FILE: CFIND.ASM

```
            ELSE
              SHLD  ABSSMD
            ENDIF
;
;
;
            RET
;
;
;
;
;
;
;
GETP2:
;
;SEE IF AT LEAST 10 POINTS IN RING BUFFER
;
            LHLD    RIPT
            LXI     D,20
            ORA     A
            DSBC    D
            IF (PSW.IS.CARRY)   ;THEN < 10 PTS
              STC
            ELSE
;
;
;SET UP INIT VALUES IN RCY1,RCY2,RCY3,RCY4
;         ABY1,ABY2,ABY3,ABY4,AND SRCOFST
;
            LXI     H,RCBUFF
            MOV     E,M
            INX     H
            MOV     D,M
            SDED    RCY1
;
            INX     H
            MOV     E,M
            INX     H
            MOV     D,M
            SDED    RCY2
;
            INX     H
            MOV     E,M
            INX     H
            MOV     D,M
            SDED    RCY3
;
            INX     H
            MOV     E,M
            INX     H
            MOV     D,M
            SDED    RCY4
```

FILE: CFIND.ASM

```
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY5
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY6
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY7
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY8
;
;
        LXI     H,ABBUFF
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY1
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY2
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY3
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY4
;
        INX     H
        MOV     E,M
        INX     H
```

FILE: CFIND.ASM

```
        MOV     D,M
        SDED    ABY5
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY6
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY7
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY8
;
        LXI     H,14    ;OFSET FOR THE 9TH VALUE IN BUFFERS
        SHLD    SRCOFST
;
        LXI     H,8     ;OFFSET OF MIDDLE OF DERI'.
        SHLD    ROPT
;
        LXI     H,0
        SHLD    INTGRC
          ORA   A
        ENDIF
        RET
;
;
        .EXTERN CFD
        .LOC    CFD
CUROFF:         .BLKB   2
OFFTEMP:        .BLKB   2
        .RELOC
;
;
        .END
;****************************************;
;
;
        .IDENT  DKFIND
        .INSERT SP80.ASM
        .INSERT CALCOM
        .INSERT FPMAC.SRC
        .INSERT EFFCOM
        .INSERT DKCOM
        .INSERT DRVCOM
        .INSERT SIOCOM
```

FILE: CFIND.ASM

```
        .ENTRY  DKFIND,DKGETP2
        .EXTERN TDHE
        .ENTRY  DERIV5
        .EXTERN PTRUPD
        FINIT
;
;
;ASSUME:  THAT ALL RC VALUES, AB VALUES, AND SUM VALUES
;         WILL HAVE FIRST 4 BITS = 0000H COMING FROM
;         A-D.
;
DKFIND:
;
;HL = OFFSET OF CURRENT PT ON ENTRANCE
;
; ON EXIT: IF CP FOUND, THEN CARRY SET AND
;         HL = SUM PT
;         DE = RIB CAGE PT
;         BC = ABDOMEN PT
;          TVALUE = TIME OF CP
;
        PUSH    H
        PUSH    H
        PUSH    H
        LXI     D,SPBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURSP
;
        POP     H
        LXI     D,RCBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURRC
;
        POP     H
        LXI     D,ABBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    CURAB
;
        POP     H
        LXI     D,TMBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
```

FILE: CFIND.ASM

```
        SDED    CURTM
;
;
;
;
;
;
        CALL    GTSIGN  ;CHECK SIGNS OF DERIVATIVES
;
;
        LDA     PTF
        IF (.A,IS,ZERO) ;LOOK FOR MIN
          LHLD  SPTEMP
          LDED  CURSP
          ORA   A
          DSBC  D
          IF (PSW,IS,NCARRY)   ;NEW TMP MIN FOUND
             LHLD       CURSP
             SHLD       SPTEMP
             LHLD       CURRC
             SHLD       RCTEMP
             LHLD       CURAB
             SHLD       ACTEMP
                LHLD    CURTM
                SHLD    SMTIME
;

;1. ADD CURRENT RCDERV PT TO RC COUNTS
;2. ADD RCTCNT TO RC COUNTS
;3. RCTCNT <== 0
;4. ADD CURRENT ABDERV TO AB COUNTS
;5. ADD ABTCNT TO AB COUNTS
;6. ABTCNT <== 0
                CALL    UPDT1

;
;
             ORA        A
             RET
          ELSE          ;POSSIBLE CP SO CHECK SLOPE BETWEEN
                        ;CURRNT PT AND TEMP PT
             LHLD       CURSP
             LDED       SPTEMP
             ORA        A
             DSBC       D
             ;NOW HL HOLDS DIFFERENCE
             LDED       MINCC
             ORA        A
             DSBC       D
             IF (PSW,IS,NCARRY)  ;THEN SMTEMP IS CP
                LHLD    SPTEMP
                PUSH    H
                LHLD    RCTEMP
```

FILE: CFIND.ASM

```
                PUSH    H
                LHLD    ABTEMP
                PUSH    H
                LHLD    SMTIME
                SHLD    TVALUE
                 LHLD   CURSP
                 SHLD   SPTEMP
                 LHLD   CURRC
                 SHLD   RCTEMP
                 LHLD   CURAB
                 SHLD   ABTEMP
                LHLD    CURTM
                SHLD    SMTIME
;
;1. STORE RC COUNTS
;2. RC COUNTS <== RCTCNT
;3. RCTCNT <== 0
;4. STORE AB COUNTS
;5. AB COUNTS <== ABTCNT
;6. ABTCNT <== 0
;
                CALL    UPDT2
;
;
                 POP    B          ;AB VALUE
                 POP    D          ;RC VALUE
;
; SET THE APPROPRIATE BIT ON RC VALUE TO INDICATE
;  A MINIMUM BRTH
                 MOV    A,D
                 ANI    0FH        ;FIRST 4 BITS SHOULD = 0000B
                  MOV   D,A
;
                 POP    H          ;SM VALUE
                 STC    ;SET CARRY
                 RET
               ELSE
           ;NOT A LARGE ENOUGH SLOPE
;
;1. ADD RCDERV TO RCTCNT
;2. ADD ABDERV TO ABTCNT
                CALL    UPDT3
;
                ORA     A
                RET
              ENDIF
            ENDIF
         ELSE               ;LOOK FOR MAX
           LHLD  SPTEMP
            LDED CURSP
           XCHG
           ORA   A
           DSBC  D
```

FILE: CFIND.ASM

```
          IF (PSW,IS,NCARRY)    ;;THEN CURRENT >= SMTEMP
            LHLD        CURSP
            SHLD        SPTEMP
            LHLD        CURRC
            SHLD        RCTEMP
            LHLD        CURAB
            SHLD        ABTEMP
                LHLD    CURTM
                SHLD    SMTIME
;
                CALL    UPDT1
;
            ORA A
            RET
          ELSE  ;POSSIBLE CP
            LHLD        SPTEMP
            LDED        CURSP
            ORA A
            DSBC        D
        ;NOW HL = DIFF
            LDED        MINCC
            ORA A
            DSBC        D
            IF (PSW,IS,NCARRY)   ;THEN SMTEMP IS CP
                LHLD    SPTEMP
                PUSH    H
                LHLD    RCTEMP
                PUSH    H
                LHLD    ABTEMP
                PUSH    H
                LHLD    SMTIME
                SHLD    TVALUE
                LHLD    CURSP
                SHLD    SPTEMP
                LHLD    CURRC
                SHLD    RCTEMP
                LHLD    CURAB
                SHLD    ABTEMP
                LHLD    CURTM
                SHLD    SMTIME
;
;
                CALL    UPDT2
                POP     B           ;AB VALUE
                POP     D           ;RC VALUE
;
; SET THE APPROPRIATE BIT ON RC VALUE TO INDICATE
;  A MAXIMUM BRTH
                MOV     A,D
                ORI     10H         ;FIRST 4 BITS SHOULD = 0001B
                MOV     D,A
;
                POP     H           ;SM VALUE
```

FILE: CFIND.ASM

```
                        STC
                        RET
                ELSE            ;NOT LARGE ENOUGH SLOPE
                        CALL    UPDT3
                        ORA     A
                        RET
                ENDIF
            ENDIF
        ENDIF
;
;
;
UPDT1:

;1. ADD CURRENT ABS(RCDERV) PT TO RC COUNTS
;2. ADD RCTCNT TO RC COUNTS
;3. RCTCNT <== 0
;4. ADD CURRENT ABS(ABDERV) TO AB COUNTS
;5. ADD ABTCNT TO AB COUNTS
;6. ABTCNT <== 0
;
                LHLD    ABSRCD
                LDA     RCINPHS
                IF (.A,IS,NZERO)        ;THEN RC IN PHASE WITH SUM
                   LDED RCIN
                   DAD  D
                   SHLD RCIN
;
                ELSE                    ;RC OUT OF PHASE WITH SUM
                   LDED RCOUT
                   DAD  D
                   SHLD RCOUT
;
                ENDIF
;
                LHLD    RCIN
                LDED    RCTICNT
                DAD     D
                SHLD    RCIN
;
                LHLD    RCOUT
                LDED    RCTOCNT
                DAD     D
                SHLD    RCOUT
;
                LXI     H,0
                SHLD    RCTICNT
                SHLD    RCTOCNT
;
;
                LHLD    ABSABD
                LDA     ABINPHS
                IF (.A,IS,NZERO)        ;THEN AB INPHASE WITH SUM
```

FILE: CFIND.ASM

```
                    LDED ABIN
                    DAD  D
                    SHLD ABIN
;
                ELSE                            ;AB OUT OF PHASE WITH SUM
                    LDED ABOUT
                    DAD  D
                    SHLD ABOUT
;
                ENDIF
;
                LHLD    ABIN
                LDED    ABTICNT
                DAD     D
                SHLD    ABIN
;
                LHLD    ABOUT
                LDED    ABTOCNT
                DAD     D
                SHLD    ABOUT
;
                LXI     H,0
                SHLD    ABTICNT
                SHLD    ABTOCNT
;
;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE VALUES
;     ADD THEM ALL
;
                LHLD    ABSSMD
                LDED    SMIO
                DAD     D
                SHLD    SMIO
;
;
                LHLD    SMIO
                LDED    SMTCNT
                DAD     D
                SHLD    SMTCNT
;
;
                LXI     H,0
                SHLD    SMTCNT
                RET
;
;
UPDT2:
;
;1. STORE RC COUNTS
;2. RC COUNTS <== RCTCNT
;3. RCTCNT <== 0
;4. STORE AB COUNTS
;5. AB COUNTS <== ABTCNT
;6. ABTCNT <== 0
```

FILE: CFIND.ASM

```
        LHLD  RCIN
        SHLD  RCINVOL
;
        LHLD  RCOUT
        SHLD  RCOUTVOL
;
        LHLD  RCTICNT
        SHLD  RCIN
;
        LHLD  RCTOCNT
        SHLD  RCOUT
;
        LXI   H,0
        SHLD  RCTICNT
        SHLD  RCTOCNT
;
        LHLD  ABIN
        SHLD  ABINVOL
;
        LHLD  ABOUT
        SHLD  ABOUTVOL
;
        LHLD  ABTICNT
        SHLD  ABIN
;
        LHLD  ABTOCNT
        SHLD  ABOUT
;
        LXI   H,0
        SHLD  ABTICNT
        SHLD  ABTOCNT
;
;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE
        LHLD  SMIO
        SHLD  SMVOL
;
;
        LHLD  SMTCNT
        SHLD  SMIO
;
;
        LXI   H,0
        SHLD  SMTCNT
      RET
;
;
;
;
UPDT3:
;
;1. ADD ABS(RCDERV) TO RCTCNT
;2. ADD ABS(ABDERV) TO ABTCNT
;
```

FILE: CFIND.ASM

```
        LDA     RCINPHS
        IF (.A,IS,NZERO)            ;THEN INPHASE
          LHLD  ABSRCD
          LDED  RCTICNT
          DAD   D
          SHLD  RCTICNT
        ELSE
          LHLD  ABSRCD
          LDED  RCTICNT
          DAD   D
          SHLD  RCTOCNT
        ENDIF
;
        LDA     ABINPHS
        IF (.A,IS,NZERO)
          LHLD  ABSABD
          LDED  ABTICNT
          DAD   D
          SHLD  ABTICNT
        ELSE
          LHLD  ABSABD
          LDED  ABTOCNT
          DAD   D
          SHLD  ABTOCNT
        ENDIF
;
;SUM: DO NOT SEPERATE INPHASE AND OUT OF PHASE
;
          LHLD  ABSSMD
          LDED  SMTCNT
          DAD   D
          SHLD  SMTCNT
;
        RET
;
;
;

;
;
;
GTSIGN:
        LHLD    RCDERV   ;CURRENT RC DERIV VALUE
        MOV     A,H
        ANI     80H
        STA     RCSIGN
;
        LHLD    ABDERV   ;CURRENT AB DERIV VALUE
        MOV     A,H
        ANI     80H
        STA     ABSIGN
;
        LHLD    SMDERV
```

```
        MOV     A,H
        ANI     80H
        STA     SMSIGN
;
;
        MOV     B,A
        LDA     RCSIGN
        IF (.A,EQ,.B)    ;THEN RC INPHASE W/ SUM
          XRA   A
          CMA
          STA   RCINPHS
        ELSE
          XRA   A
          STA   RCINPHS
        ENDIF
;
        LDA     SMSIGN
        MOV     B,A
        LDA     ABSIGN
        IF (.A,EQ,.B)    ;THEN AB INPHASE W/ SUM
          XRA   A
          CMA
          STA   ABINPHS
        ELSE
          XRA   A
          STA   ABINPHS
        ENDIF
        RET
;
;
;
;
;
;
;
;
;
DERIV5:
;***********************
;DERIV USING 9 POINTS
;***********************
;
;DERIVATIVE USING 5 POINTS
;
;SRCOFST HOLDS OFFSET TO GET Y5 FROM RAW DATA BUFFERS
;
;ASSUME: RCY1,RCY2,RCY3,RCY4, ABY1,ABY2,ABY3,ABY4 ALREADY SET
;
        LXI     D,RCBUFF
        LHLD    SRCOFST
        DAD     D
        MOV     E,M
        INX     H
```

FILE: CFIND.ASM

```
        MOV     D,M
        SDED    RCY9
;
        LHLD    SRCOFST
        LXI     D,ABBUFF
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY9
;
        LXI     B,RSIZE ;UPDATE FOR NEXT TIME
        LHLD    SRCOFST
        CALL    PTRUPD
        SHLD    SRCOFST
;DERIV = (9-1)*4  + (8-2)*3  + (7-3)*2  + (6-4)
;
        LHLD    RCY9
        LDED    RCY1
        ORA     A
        DSBC    D
        DAD     H       ;(RCY9-RCY1)*2
        DAD     H       ;(RCY9-RCY1)*4
        PUSH    H
;
        LHLD    RCY8
        LDED    RCY2
        ORA     A
        DSBC    D
        MOV     E,L
        MOV     D,H
        DAD     H       ;*2
        DAD     D       ;*3
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    RCY7
        LDED    RCY3
        ORA     A
        DSBC    D
        DAD     H
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    RCY6
        LDED    RCY4
        ORA     A
        DSBC    D
        POP     D
        DAD     D
        SHLD    RCDERV
```

FILE: CFIND.ASM

```
;
;*****: DIVIDE RCDERV BY 4 TO AVOID OVERFLOW WHEN INTEGRATING IT
        LHLD    RCDERV
        SRAR    H
        RARR    L
        SRAR    H
        RARR    L
        SHLD    RCDERV

;***
;DERIV = (9-1)*4  + (8-2)*3  + (7-3)*2  + (6-4)
;
        LHLD    ABY9
        LDED    ABY1
        ORA     A
        DSBC    D
        DAD     H       ;(ABY9-ABY1)*2
        DAD     H       ;(ABY9-ABY1)*4
        PUSH    H
;
        LHLD    ABY8
        LDED    ABY2
        ORA     A
        DSBC    D
        MOV     E,L
        MOV     D,H
        DAD     H       ;*2
        DAD     D       ;*3
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    ABY7
        LDED    ABY3
        ORA     A
        DSBC    D
        DAD     H
        POP     D
        DAD     D
        PUSH    H
;
        LHLD    ABY6
        LDED    ABY4
        ORA     A
        DSBC    D
        POP     D
        DAD     D
        SHLD    ABDERV
;
;*****: DIVIDE ABDERV BY 4 TO AVOID OVERFLOW WHEN INTEGRATING IT
        LHLD    ABDERV
        SRAR    H
        RARR    L
```

FILE: CFIND.ASM

```
        SRAR    H
        RARR    L
        SHLD    ABDERV

;***
;
;RESET VALUES FOR NEXT TIME
        LHLD    RCY2
        SHLD    RCY1
        LHLD    RCY3
        SHLD    RCY2
        LHLD    RCY4
        SHLD    RCY3
        LHLD    RCY5
        SHLD    RCY4
        LHLD    RCY6
        SHLD    RCY5
        LHLD    RCY7
        SHLD    RCY6
        LHLD    RCY8
        SHLD    RCY7
        LHLD    RCY9
        SHLD    RCY8
;
        LHLD    ABY2
        SHLD    ABY1
        LHLD    ABY3
        SHLD    ABY2
        LHLD    ABY4
        SHLD    ABY3
        LHLD    ABY5
        SHLD    ABY4
        LHLD    ABY6
        SHLD    ABY5
        LHLD    ABY7
        SHLD    ABY6
        LHLD    ABY8
        SHLD    ABY7
        LHLD    ABY9
        SHLD    ABY8
;
;
        LHLD    RCDERV
        LDED    ABDERV
        DAD     D
        SHLD    SMDERV
;
;
;COMPUTE ABSOLUTE VALUE OF RCDERV AND ABDERV, AND SMDERV
        LHLD    RCDERV
        MOV     A,H
        ANI     80H
        IF (.A,IS,NZERO)        ;THEN RCDERV < 0
```

FILE: CFIND.ASM

```
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSRCD
        ELSE
          SHLD  ABSRCD
        ENDIF
;
        LHLD    ABDERV
        MOV     A,H
        ANI     80H
        IF (.A.IS,NZERO)          ;THEN ABDERV < 0
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSABD
        ELSE
          SHLD  ABSABD
        ENDIF
;
        LHLD    SMDERV
        MOV     A,H
        ANI     80H
        IF (.A.IS,NZERO)          ;THEN SMDERV < 0
          MOV   A,L
          CMA
          MOV   L,A
          MOV   A,H
          CMA
          MOV   H,A
          INX   H
          SHLD  ABSSMD
        ELSE
          SHLD  ABSSMD
        ENDIF
;
;
;
        RET
;
;
;
;
;
;
```

FILE: CFIND.ASM

```
;
DKGETP2:
;
;SEE IF AT LEAST 10 POINTS IN RING BUFFER
;
        LHLD    RIPT
        LXI     D,20
        ORA     A
        DSBC    D
        IF (PSW,IS,CARRY)   ;THEN < 10 PTS
          STC
        ELSE
;
;
;SET UP INIT VALUES IN RCY1,RCY2,RCY3,RCY4
;         ABY1,ABY2,ABY3,ABY4,AND SRCOFST
;
        LXI     H,RCBUFF
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY1
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY2
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY3
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY4
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY5
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D.M
        SDED    RCY6
;
```

FILE: CFIND.ASM

```
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY7
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    RCY3
;
;
        LXI     H,ABBUFF
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY1
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY2
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY3
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY4
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY5
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY6
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
```

FILE: CFIND.ASM

```
        SDED    ABY7
;
        INX     H
        MOV     E,M
        INX     H
        MOV     D,M
        SDED    ABY8
;
        LXI     H,14     ;OFSET FOR THE 9TH VALUE IN BUFFERS
        SHLD    SRCOFST
;
        LXI     H,8      ;OFFSET OF MIDDLE OF
        SHLD    ROPT
;
        LXI     H,0
        SHLD    INTCPC
          ORA   A
        ENDIF
        RET
;
        .END
```

```
        .IDENT  PRNTVAL
       .INSERT FPMAC.SRC
       .INSERT SP80.ASM
       .INSERT CALCOM
       .INSERT LP2COM
       .INSERT SYCOM
;
       .EXTERN PRTIME
;
       .EXTERN LPON,LPOFF
       FINIT
       .EXTERN ROUND
       .ENTRY  PRNTVAL
;
; THIS ROUTINE PRINTS OUT THE DELTA VALUES:
;
;    SUM       SP      SUM/SP
;
;
;
; THERE ARE (2*MAXCNT) -1 VALUES
;
;
;
PRNTVAL:
;
;ASSUME VALUE OF FCNT IS IN AREG ON ENTRY TO THIS ROUTINE
;
       FSTA     FCNT
;ONLY MAKE HARD COPY
G01:
       LHLD     MAXCNT
       DCX      H
       SLAR     L
       RALR     H
       SHLD     CNT
       LIQI     4
       LXI      H,XVALUES
       SHLD     X2PTR
       LXI      H,0
       SHLD     CPPTR     ;OFFSET FOR SP,RC,AB
       XRA      A
       STA      PTF       ;THIS IS ZERO WHEN
                          ;ODD # TIME THRU LOOP
;
           XRA A
           CMA
           STA HRDFLG
;
       MVI      A,10
       STA      LCNT
;ONLY MAKE HARD COPY
         CALL   LPON
```

```
;OUTPUT SEVERAL LINE FEEDS
          LXI    H,CRLFS
          CALL   TXTYP
          CALL   PRTIME
          FPRN   HEAD,HDPT
          CALL   LPOFF
;
LOOP1:
;
;GET THE DELTA FOR SPIROMETER
;
        LHLD     CPPTR
        LXI      D,SPMAX
        DAD      D
        MOV      E,M
        INX      H
        MOV      D,M
        SDED     SPVALUE
;
        LHLD     CPPTR
        LDA      PTF
        IF (.A,IS,NZERO)    ;THEN EVEN # THRU LOOP
                 INX      H
                 INX      H
        ENDIF
        LXI      D,SPMIN
        DAD      D
        MOV      E,M
        INX      H
        MOV      D,M
                          ;DE = MIN SP PT
        LHLD     SPVALUE  ;HL = MAX SP PT
        ORA      A
        DSBC     D
        SHLD     SPDELT   ;SP DELTA
        FILA     SPDELT
        FLOT
        FLDB     CCS
        FMUL
        FSTA     SPDELT   ;NOW INTERMS OF ML
;
;NOW GET SUM DELTA VALUE
;
;
        LHLD     CPPTR
        LXI      D,ABMAX
        DAD      D
        MOV      E,M
        INX      H
        MOV      D,M
        SDED     ABVALUE
;
        LHLD     CPPTR
```

```
        LDA     PTF
        IF (.A,IS,NZERO)   ;THEN EVEN # THRU LOOP
                INX     H
                INX     H
        ENDIF
        LXI     D,ABMIN
        DAD     D
        MOV     E,M
        INX     H
        MOV     D,M
                        ;DE = MIN SUM PT
        LHLD    ABVALUE ;HL = MAX SUM PT
        ORA     A
        DSBC    D
        SHLD    ABDELT  ;SUM DELTA VALUE
        FILA    ABDELT
        FLOT
        FLDB    CCS
        FMUL
        FSTA    ABDELT  ;NOW IN ML
;
;
;NOW GET XVALUE (SUM/SP)
        LDQR    X2PTR
        FQWL
        FSTA    XVAL
        SDQR    X2PTR
;
;ONLY MAKE HARD COPY
          CALL  LPON
          LDA   PTF
          IF (.A,IS,ZERO)        ;THEN INSP
            LXI H,ILAB
          ELSE
            LXI H,ELAB
          ENDIF
          CALL  TXTYP
          FPRN  DELT,DELTPT
          CALL  LPOFF
;
;
;
        LDA     PTF
        IF (.A,IS,NZERO)   ;THEN EVEN # THRU LOOP
           LHLD CPPTR
           INX  H
           INX  H
           SHLD CPPTR
        ENDIF
        LDA     PTF
        CMA
        STA     PTF
;
```

```
        DSKZ    CNT,LOOP1
;
;
LP11:
;
;CALUCULATE AND PRINT OUT THE MEAN, STD, ST ERROR, AND % ERROR
;
        FLDB    XSUM
        FLDA    FCNT
        FDIV
        FSTA    MEAN
;
;
        FLDB    XSUM
        FLDA    XSUM
        FMUL
        FATB
        FLDA    FCNT
        FDIV
        FLDB    XXSUM
        FSUB
        FATB
        FLDA    FCNT
        FDIV
        FSQR
        FSTA    STDV
        FLDA    FCNT
        FSQR
        FLDB    STDV
        FDIV
        FSTA    STERR
;
        FLDB    MEAN
        FFOA    1
        FSUB
        FATB
        FFOA    100
        FMUL
        FSTA    PCERR
        FLDA    PCERR
        FABS
        FATB
        FFOA    1
        FSUB
        FSTA    FTEMP
        FTST    FTEMP,LT
        IF (PSW,IS,ZERO)            ;THEN ABS(ERROR) < 1
          FFOA  0
          FSTA  PCERR
        ENDIF
;
G02:
;
```

```
;ONLY MAKE HARD COPY
        CALL  LPON
        FPRN  STATS,STPT
;OUTPUT SEVERAL LINE FEEDS
        LXI   H,CRLFS
        CALL  TXTYP
        CALL  LPOFF
;
;
      RET
;
;
STATS: .ASCIS  '
Mean SUM/SP         = @D3
Stdv SUM/SP         = @D3
St Err SUM/SP       = @D3

% ERROR             = @D1 %

'
;
STPT:  .WORD   MEAN,STDV,STERR,PCERR
;
ILAB:  .ASCIS  '(I)
ELAB:  .ASCIS  '(E)     '
;
;
DELT:  .ASCIS  '@D3    @D3     @D3
'
;
DELTPT:        .WORD   ABDELT,SPDELT,XVAL
;
HDPT:
;
HEAD:  .ASCIS  '
      Validation:
      SUM     SP      SUM/SP
'
CRLFS: .ASCIS  '


'
;
;
;
      .EXTERN PRT
      .LOC    PRT
FTEMP: .BLKB   4
;
SPDELT:        .BLKB   4
RCDELT:        .BLKB   4
Y2PTR: .BLKB   2
X2PTR: .BLKB   2
ABDELT:        .BLKB   4
```

```
LCNT:   .BLKB   1
FCNT:   .BLKB   4
;
MEAN:   .BLKB   4
STDV:   .BLKB   4
STERR:  .BLKB   4
PCERR:  .BLKB   4
LOOPCNT:        .BLKB   1
;
        .RELOC
        .END
```

FILE: VSETUP.ASM

```
;
;IF VALIDATING AND IF USING SPIROBAG
; THEN SPVALUE HOLDS THE SUM MIN
                LDA     BAG
                IF (.A,IS,NZERO)          ;THEN USING SPIROBAG
                 LDED   SPVALUE           ;SUM VALUE
                 JMP    L2001
                ENDIF
;
                LDED    ABVALUE
L2001:
                MOV     M,E
                INX     H
                MOV     M,D
          ENDIF
        LDA     PTF
        CMA
        STA     PTF
        ENDIF
;
SKIP5:
;
EXIT:
;
        CALL    CSTS
        IF (PSW,IS,NZERO)
          CALL  CINP
          IF (.A,EQ,CR) ;IF CARRIAGE RETURN
             JMP        CLKSTP
          ENDIF
        ENDIF
;
        XRA     A
        STA     INTFLG
;
;********************
        POP     PSW
        POP     H
        POP     D
        POP     B
;
        RET
;
;
;
CLKTIK:
;
        LHLD    ELPTM
        INX     H
        SHLD    ELPTM
        LDED    SFREQ
        CALL    TDHE
        IF (PSW,IS,ZERO)          ;THEN 1 SECON
```

FILE: VSETUP.ASM

```
            LXI    H,0
            SHLD   ELPTM
            LHLD   SECONDS
            INX    H
            SHLD   SECONDS
            XRA    A
            CMA
            STA    SECFLG
            LXI    D,60
            CALL   TOHE
            IF (PSW,IS,ZERO)       ;THEN 1 MINUTE
              LXI H,0
              SHLD         SECONDS
              LHLD         ELPMIN
              INX H
              SHLD         ELPMIN
            ENDIF
          ENDIF
          RET
;
;
;
SAMPLE:
;
;
;
          LDA      BAG
          IF (.A,IS,ZERO) ;THEN USING SPIROMETER
            LHLD   SMAD     ;SUM VALUE
            MOV    A,H
            CMA
            ANI    0FH
            MOV    H,A
            MOV    A,L
            CMA
            MOV    L,A
            SHLD   DATA
            LHLD   RIPT
            LXI    D,ABBUFF
            CALL   PRNG
;
;
            LHLD   SPAD     ;SPIROMETER VALUE
            MOV    A,H
            CMA
            ANI    0FH
            MOV    H,A
            MOV    A,L
            CMA
            MOV    L,A
            SHLD   DATA
            LDA    PNFLAG
            IF (.A,IS,NZERO)       ;THEN INPUTTING PNEUMOTACH-SO INTEGRATE
```

FILE: VSETUP.ASM

```
;NOTE:**** ASSUME 0 FLOW IS AT 7FFH
            LHLD        DATA
            LXI D,7FFH
            ORA A
            DSBC        D
;DIVIDE BY 8 (SIGNED SHIFT RIGHT)
;CHANGE TO SHIFT ONLY 2 TIMES
;2BYTES PER INSTRUCTION
            NOP
            NOP
;
           NOP
            NOP
;    SRAR        H
;    RARR        L
           SRAR H
           RARR L
           SRAR H
           RARR L
           LDED PNSUM
           DAD  D
           SHLD PNSUM
;ADD OFFST SO ALL # > 0
           LXI  D,800H
           DAD  D
           SHLD DATA
         ENDIF
         CALL    CKFLIP
         LHLD    RIPT
         LXI     D,SPBUFF
         CALL    PRNG
;
        ELSE               ;USING FIXED VOLUME
;STORE SUM DATA IN SPBUFF SO WILL BE USED TO PICK OFF BREATHS
;
          LHLD   SMAD      ;SUM VALUE
          MOV    A,H
          CMA
          ANI    0FH
          MOV    H,A
          MOV    A,L
          CMA
          MOV    L,A
          SHLD   DATA
          LHLD   RIPT
          LXI    D,SPBUFF
          CALL   PRNG
;
;FILL ABBUFF WITH ZEROES
          LXI    H,0
          SHLD   DATA
          LHLD   RIPT
          LXI    D,ABBUFF
```

```
              CALL  PRNG
;
;
           ENDIF
;
;
;FILL RCBUFF WITH ZEROES
           LXI     H,0
           SHLD    DATA
           LHLD    RIPT
           LXI     D,RCBUFF
           CALL    PRNG
;
;
;
;
;
;INCREMENT RIPT FOR NEXT TIME
;
           LHLD    TIME
           INX     H
           SHLD    TIME
           SHLD    DATA
           LHLD    RIPT
           LXI     D,TMBUFF
           CALL    PRNG
;
           LHLD    RIPT
           SHLD    ODRIPT
           LXI     B,RSIZE
           LHLD    RIPT
           CALL    PTRUPD
           SHLD    RIPT
;
           LDA     WRAPF
           IF (.A,IS,ZERO) ;SEE IF RIPT RESET TO 0
             LXI   D,0
             LHLD  RIPT
             CALL  TDHE
             IF (PSW,IS,ZERO)
               MVI A,0FFH
               STA WRAPF
             ENDIF
           ENDIF
           RET
;
;
;
CKFLIP:
;
;CHECK IF NEED TO FLIP
           LDA     FLIPV
           IF (.A,IS,NZERO)
```

In practice, the Respigraph ^{TM} scaling amplifiers for the rib cage and abdomen signals are initially set at unity gain. A 10 minute baseline is then taken. The program automatically computes the delta values for the rib cage and abdomen signals, discards the wild points, computes the mean values for the rib cage and abdomen from the totals of the remaining delta values, computes the standard deviations for those means, and then computes the proportionality factor Z from Equation M. The scaling amplifier for the rib cage is then adjusted to the proportionality factor Z. The real time output from the Respigraph ^{TM} representing the sum of the rib cage and abdomen signals is then proportional to tidal volume as explained more fully above. The program also recomputes the proportionality factor Z during each subsequent 5 minute interval. If the recomputed value differs from 1.0 by more than an acceptable amount, the calibration routine can be rerun. The program also computes the scaling factor M from Equation N if instructed to do so upon inputting an actual tidal volume value as derived, e.g., by spirometry.

While there has been shown and described herein a preferred embodiment of the present invention and certain suggested modifications thereto, it will be apparent that further changes and modifications may be made without departing from the spirit and scope of the invention. Accordingly, the foregoing description should be construed as illustrative and not in the limiting sense, the scope of the invention being defined by the following claims.

Claim 1

1. In a method for non-invasively measuring a subject's respiration volume of the type including providing a signal responsive to a rib cage dimension indicative of rib cage contribution to respiration volume, providing a signal responsive to an abdominal dimension indicative of abdominal contribution to respiration volume, multiplying at least one of said rib cage and abdominal signals by predetermined weighting factors reflecting the relative contributions of said rib cage and abdomen to respiration volume, and summing said weighted signals for providing a signal proportional to respiration volume, the improvement comprising non-invasively determining said weighting factors by

(a) totaling the delta values for said rib cage signal over a baseline period of substantially steady state breathing;

(b) totaling the delta values for said abdomen signal over a baseline period of substantially steady state breathing;

(c) dividing the average variability of the mean of the total of said delta values for one of said rib cage or abdomen signals by the average variability of the mean of the total of said delta values for the other of said rib cage or abdomen signals; and

(d) and multiplying said other signal by a weighting factor equaling the quotient derived from step (c).

FIG. 1

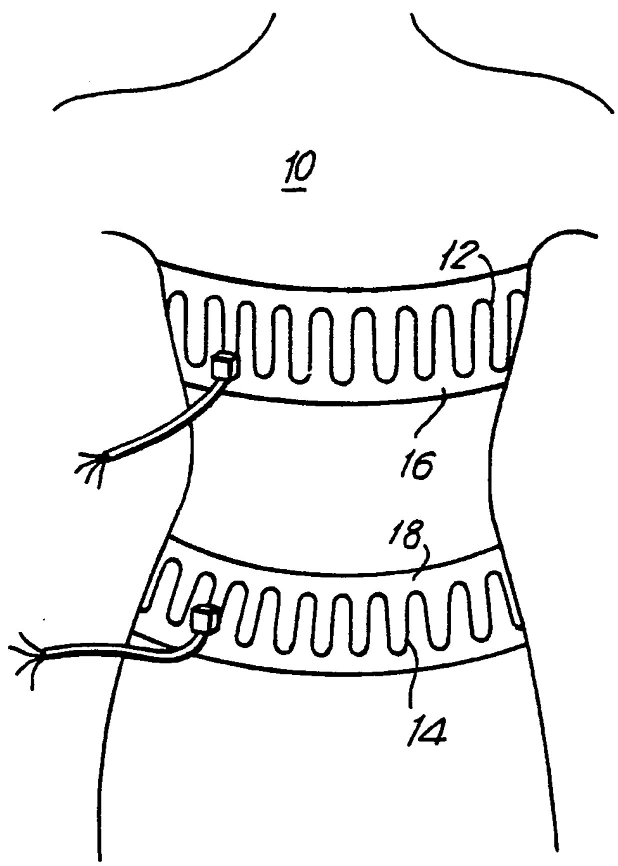
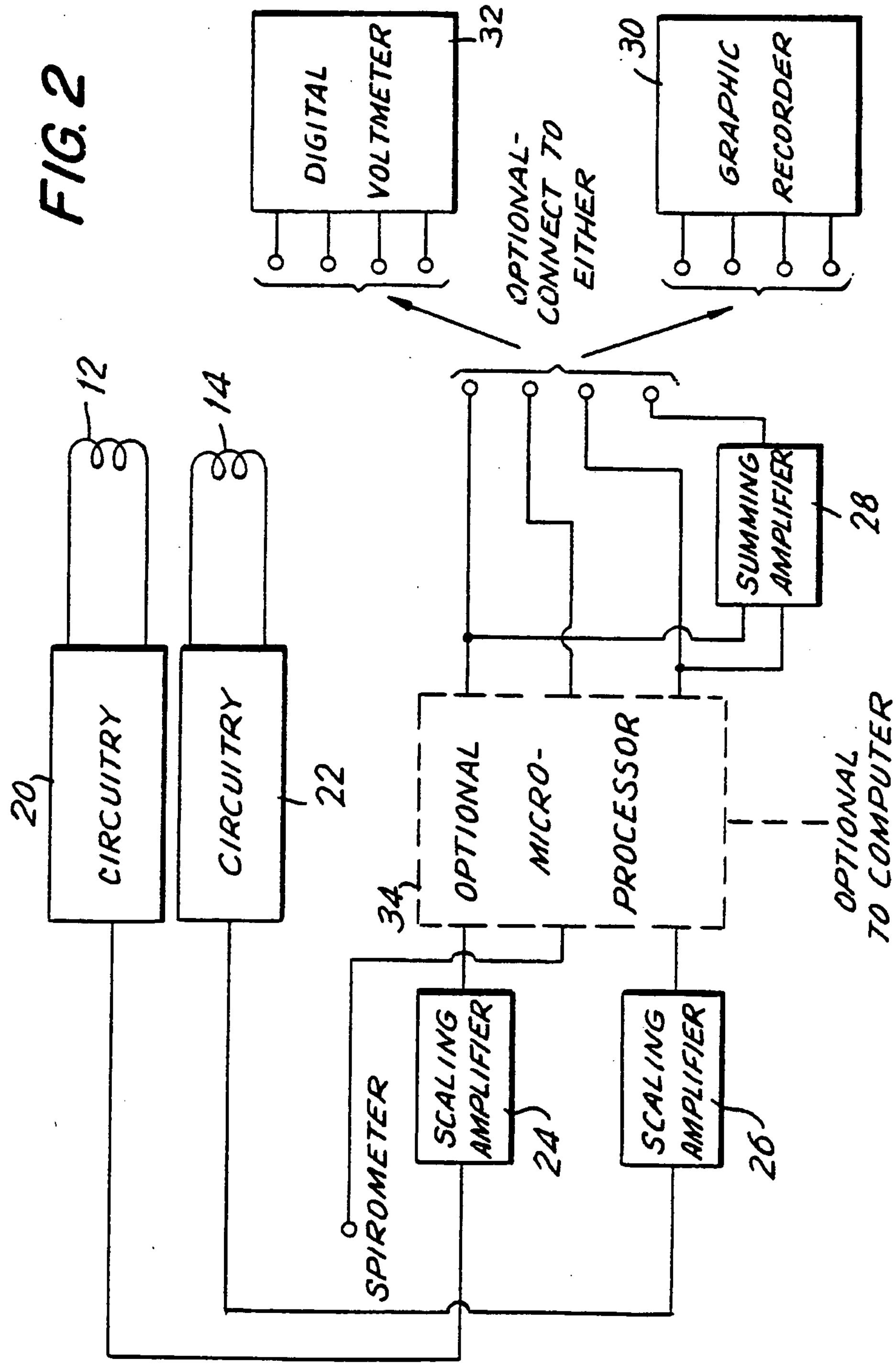
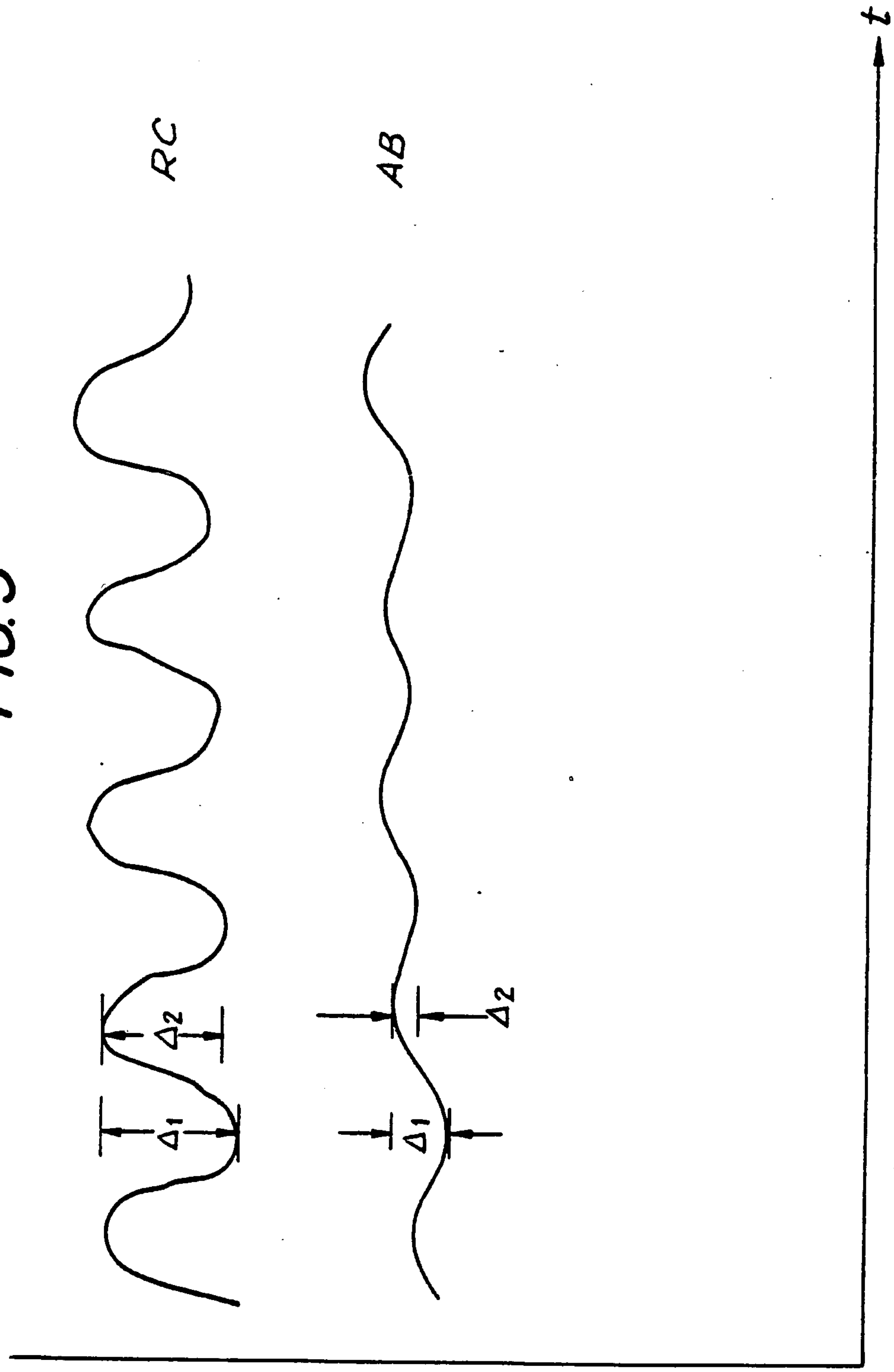


FIG. 2



DIGITAL VOLTMETER
32
30
GRAPHIC RECORDER
OPTIONAL- CONNECT TO EITHER
12
14
CIRCUITRY
20
CIRCUITRY
22
SUMMING AMPLIFIER
28
OPTIONAL MICRO- PROCESSOR
34
OPTIONAL TO COMPUTER
SPIROMETER
SCALING AMPLIFIER
24
SCALING AMPLIFIER
26

FIG. 3



INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/00217

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): A61B 5/08
U.S. Cl. 128/721, 725

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	128/716, 721, 725

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, A, 4,373,534 (WATSON) 15 February 1983 See the entire document.	1
A	US, A, 4,308,872 (WATSON ET AL) 05 January 1982, see the entire document.	1
A	US, A, 4,267,845 (ROBERTSON ET AL) 19 May 1981, see column 3, lines 21-32.	1

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
25 March 1987	15 APR 1987
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	John Hanley John Hanley

Form PCT/ISA/210 (second sheet) (May 1986)